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Learner Modelling Using Semantic Web Technology

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Abstract:- Nowadays, e-learning needs to be more adaptive and flexible to support learners. However, most current e-learning systems provide the same content for learners with different requirements. They ignore learners' differences in for example learning styles, cognitive styles, knowledge levels and backgrounds. The problem of delivering the same content to all learners can be addressed by adapting the content to each individual's needs. This paper presents a novel ontology-based approach to represent learner's profile in an attempt to get closer to a personalized e-Learning system.

Keywords: Learner mode, Ontology, Personalized learning, Semantic technology.

1. Introduction

In an educational context, users with different learning abilities and background knowledge essentially require different learning paths[1]. Personalized adaptive learning systems are able to tailor learning content and learning paths to individual's abilities, preferences, needs and knowledge in order to enhance the learner's understanding of the learning content [2-5].

Personalization is an important issue for web-based educational systems from two aspects:

firstly, most web-based e-learning systems are used by a much wider diversity of learners with different requirements; secondly, learners usually work with web-based e-learning systems individually and therefore can't get the intelligent and personalized assistance a teacher provides in a classroom [6]. To overcome these problems, many researchers have recently attempted to take into account learner's level of knowledge into their training by building a model for each learner [7-14]. The Learner model is a kind of user model which represents the learning characteristics of the learners. Consequently, the e-learning systems get a perception of learner using this model could be adapted for them.

Recently, we have seen a trend in using ontologies to represent and manage human knowledge. Similarly, in the field of personalized e-learning, ontologies can be used to represent the component of personalization such as a learner and the domain. Ontology supports the representation of abstract concepts and relations between them which makes it easily to be reused in different applications and which also enables reasoning on the information represented inside the ontology.

In this paper we focus on utilizing the semantic web technologies - ontologies in particular- for modelling a learner which involves five aspects: learner's personal information, prior knowledge, preferences, cognitive and learning style.

The paper is organized as follows. The following section gives a background of ontology that our approach is based on. Section 3 presents our ontology-based learner model. Finally, some conclusions are given in section 4.

2. Ontologies

Ontology is an explicit specification of a conceptualization [15]. It facilitates formal representation of knowledge and formal reasoning to support explicit semantics and automated processing (Vesin et al., 2012). In the field of personalized e-learning, ontologies are applied to model knowledge about learning

content, learner's profile and teaching strategies. An ontology-based semantic model provides high level modelling capabilities to represent major components of personalization in e-learning systems and also provides reasoning mechanisms to accomplish further semantic enrichment steps that can perform the adaptation process.

Ontologies can provide abstract description of learning contents by providing the terminology and thesaurus functionalities to annotate resources [16]. Annotation is a form of attaching information (metadata) to an existing resource [17]. The information in learning content document can be categorized into definitions or explanations about a new concept, examples, exercises, procedure and so on. Ontologies provide syntactically and semantically suitable annotations to present this classification explicitly. For example, the TANGRAM system [18] supports ontology-based, fine-grained annotation of learning content to make individual components of learning contents searchable and reusable. It automates this annotation process using concepts or terms extracted from a number of ontologies. In this system, the ontologies help to specify the structure of learning content formally and annotate individual components of learning content semantically.

The underlying technology of personalized e-learning systems is the use of a learner model as it represents the learner's knowledge level, needs and preferences. The system uses this information to adapt content to individual learners. Therefore, several attempts have been made to implement ontology-based learner model [11, 14]. For instance, ADAPT2 [19] is an Advanced Distributed Architecture for Personalized Teaching & Training which focus on ontology-based approach for sharing student profiles between different learning systems([19]. The main idea of the ADAPT2 approach is the use of an Ontology Server to exchange user models.

Furthermore, Brut et al.[20] proposed a rule-based solution for developing learner model in an e-learning system. In the proposed method, a two layers user model (competences and interests) is designed through ontological constructs. The user model provides personalized functionalities, especially with recommendations on potential collaborators for the users of an e-learning system. Correspondingly, Vesin et al. [21] proposed an ontology-based learner model in Java tutoring system. This approach uses rule-based reasoning for implementing adaptation in web-based Programming Tutoring System (Protus) where the learner model is updated as a result of firing the semantic rules.

Kaya et al. [22] proposed an ontology based learner model for e-learning systems which use instructional learning objects. The proposed model use domain and curriculum ontologies to place a new learner in a proper learning location.

3. Ontology-Based Learner Model

We propose a learner model ontology which presents personal information and learning characteristics of the different learners. The learner model is updated according to the learner's interactions with the system. Figure 1 depicts the graphical representation of the Learner model.

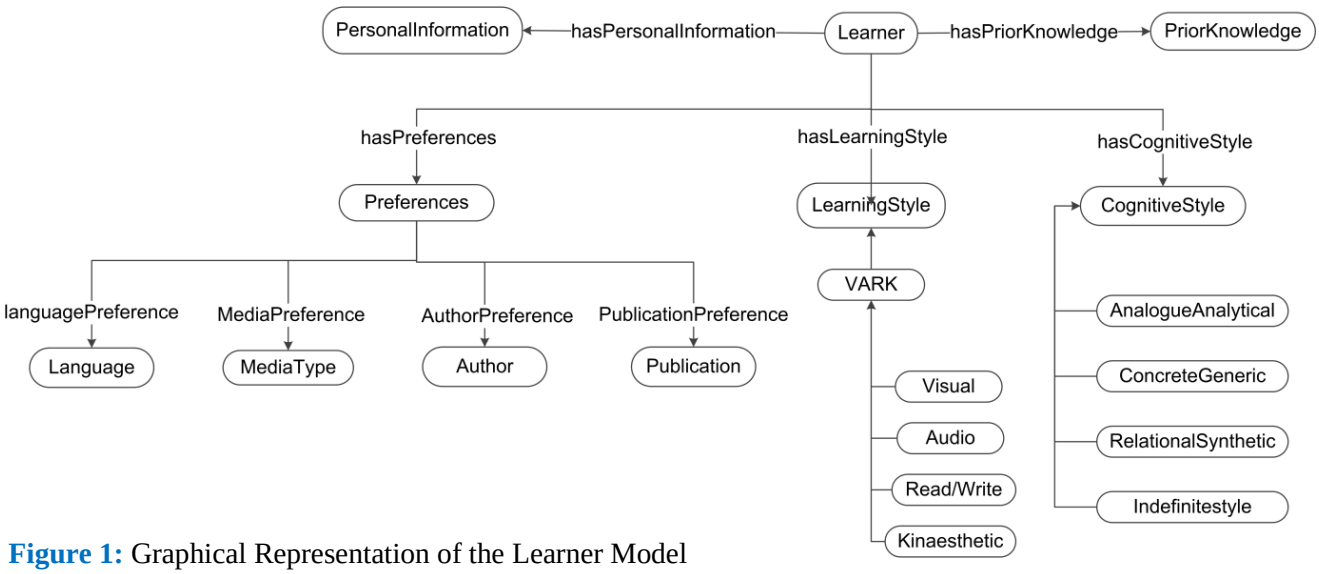

Figure 1: Graphical Representation of the Learner Model

The main class of this ontology is the Learner class to represent details about learners. Around this class, several classes are defined to represent learners' characteristics which are used for identification and adaptation process.

Personal Information class has some data properties to annotate learner in terms of the basic individual information such as name, date of birth, email, login account and so on. The system can identify the learner through this personal information.

Learner's prior knowledge level is one of the most important factors for adaptation process. The accurate diagnosis of the learner's prior knowledge level is very crucial as it uses to decide which topics should be enabled for the individual learner to learn and which should not. Each learner has a set of prior knowledge related data which is presented in Prior Knowledge class via has Prior Knowledge property. This class contains information about the learner's background knowledge and gained knowledge from previous steps of the learning process via this system (Yarandi et al., 2012d). Gained knowledge can be obtained as a result of assessments which are taken from learners. Prior Knowledge class has following data properties for recording the learner's knowledge [23]:

1. The related Topic property refers to the topic of the domain ontology that describes the topic of learner's acquired knowledge
2. The PK Score property represents the percentage score which is calculated based on the learner's response to the presented test.
3. The recorded Date property keeps the date when the learner completed the test.
4. The test Id property refers to the identification of completed test by the learner. If the learner needs to repeat this topic, this property prevents presenting the same test repeatedly.

Learner's preferences are another important factor which impact on adaptation process. When the contents are interesting for the learner, the learning performance will be increased.

The Preferences class presents the learner's preferences regarding media type, author, publication and language.

Cognitive style is another key factor which should be consider in designing adaptive learning. Different learners have their own way of thinking, reasoning and building knowledge. Learner's cognitive style can be inferred from cognitive tests as the Ross and Wilkin tests [24]. The cognitive style has been classified in five groups: Analogue-Analytical, Concrete-Generic, Deductive-Evaluative, Relational-Synthetic and Indefinite style.

The Analogue-Analytical learners like the concepts didactic materials. The Concrete-Generic learners prefer exercise didactic materials. The Relational-Synthetic learners prefer evaluation review didactic material and finally, Concrete-Generic and Relational-Synthetic learners prefer example didactic materials [24].

Therefore, in learner model ontology, we define cognitive Style class to represent learner's cognitive characteristics. This class has five instances namely Analogue Analytical, Concrete Generic, Deductive Evaluative, Relational Synthetic and Indefinite style.

Finally, the learning Style class holds information about the learner's learning style based on VARK learning model [25]. The VARK Learning model influences the nature and form of the delivered learning material. The acronym VARK stands for Visual, Aural, Read/write and Kinesthetic sensory modalities that are used for learning information. Learner's learning style is determined in registration process through fill in VARK questionnaire.

The learner model gets progressively updated following learners' interaction with the system. In details, learners are engaged in learning conceptually pre-defined topics, complete exercises and take tests, while the system should continuously recognize changes in the learner's knowledge and abilities as they progress and update the learner model accordingly [26].

4. Conclusion

Personalization is one of main factors which can be used to enhance the pedagogical impact of e-learning experiences. In personalized e-learning systems, it is essential to have knowledge about learners and to identify how this knowledge should be represented. In this paper, we present an ontological learner model to represent learner's prior knowledge, preferences, cognitive style and learning styles. The system recognizes the changes in the learner's level of knowledge as they progress. Accordingly, the learner model is updated based on the learner's progress. Consequently, the passage from one stage of the learning process to the next stage is determined based on the updated learner's profile.

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