Journal of King Saud University – Computer and Information Sciences (2015) 27, 1–12

King Saud University

Journal of King Saud University – Computer and Information Sciences

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Using concept similarity in cross ontology for adaptive e-Learning systems

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Received 28 February 2013; revised 26 August 2013; accepted 13 March 2014
Available online 29 May 2014

KEYWORDS

e-Learning;
Fuzzy domain ontology;
Cross ontology;
Semantic similarity measure

Abstract e-Learning is one of the most preferred media of learning by the learners. The learners search the web to gather knowledge about a particular topic from the information in the repositories. Retrieval of relevant materials from a domain can be easily implemented if the information is organized and related in some way. Ontologies are a key concept that helps us to relate information for providing the more relevant lessons to the learner. This paper proposes an adaptive e-Learning system, which generates a user specific e-Learning content by comparing the concepts with more than one system using similarity measures. A cross ontology measure is defined, which consists of fuzzy domain ontology as the primary ontology and the domain expert's ontology as the secondary ontology, for the comparison process. A personalized document is provided to the user with a user profile, which includes the data obtained from the processing of the proposed method under a User score, which is obtained through the user evaluation. The results of the proposed e-Learning system under the designed cross ontology similarity measure show a significant increase in performance and accuracy under different conditions. The assessment of the comparative analysis, showed the difference in performance of our proposed method over other methods. Based on the assessment results it is proved that the proposed approach is effective over other methods.

1. Introduction

The tutoring approach which nowadays is acquiring popularity all over the world, with progresses in Information and Communication Technology (ICT) is web-based education. Various organizations, institutes, universities, schools and corporations are spending considerable amounts of time and money in expanding online substitutes like e-Learning to conventional kinds of education and training systems in urbanized nations like the United States of America, the United Kingdom, and some European countries (Thyagharajan and Nayak, 2007; Ahmadpour and Mirdamadi, 2010). Such schemes should be proficient enough in delivering the appropriate content to a learner at the exact time in the most suitable way so as to offer customized instruction and must be capable of autonomously changing (update) its performance to assure the diverse requirements of learners (Jeon et al., 2007). Technical and domain based information are organized based

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Peer review under responsibility of King Saud University.

Production and hosting by Elsevier

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http://dx.doi.org/10.1016/j.jksuci.2014.03.007

on keywords and at present, they serve as the contents of e-Learning. Modern e-Learning should incorporate new-fangled expertise in different learning activities, to accomplish extremely interactive as well as social-oriented education. However e-Learning cannot replace classroom guidance (Todorova, 2010; Šimún et al., 2007; Huang et al., 2006; Antonella and Carbonaro, 2008; Bhowmick et al., 2010).

In the e-Learning market the most proficient products are customized according to the requirements of the client (Alexakos et al., 2006). The capability to articulate World Wide Web information in a simple language that can be understood by machine and intelligent agents, thus allowing human users to trace, distribute and incorporate information in a mechanized manner was the aim of the Semantic Web (Chi, 2007). It provides a framework for dynamic, scattered and extensible structured knowledge (ontology) created on a formal logic. The semantics of the document is described in domain model (Mangalwede and Rao, 2010). Ontology is a formal representation of concepts and the relationship between them by means of an approved terminology endows with an affluent set of structures to put up a supplementary significant level of information. Ontology can get the straightforward appearance of a taxonomy of perceptions (i.e., lightweight ontology), or the further wide-ranging illustration of encompassing a taxonomy in addition to the axioms and constraints which distinguish several outstanding features of the real world (i.e., heavy weight ontology) (Bianchi et al., 2009).The semantic web technology has the potentiality to be employed in diverse areas. One of the domains which perhaps will take advantage from this web technology is e-Learning (Dutta, 2006). The ontology accounts for a common and instinctive way of the organization of a course (Colace et al., 2004). Concept maps are utilized to obtain and characterize the knowledge composition such as concepts and propositions as perceived by individuals (Horrocks et al., 2004). Concept maps are analogous to ontology in the sense that both of these tools are employed to correspond to concepts and the semantic relationships among concepts.

A number of methods have been developed to study and improvise the efficiency of the ontology based techniques for optimization of the process. Bianchi et al. (2009) introduced the use of Semantic Web services within Aqua Ring and ontology was used to support educational content explanation and retrieval. Snae and Brueckner (2007) presented an e-Learning management system with metadata that provided a general template for the situation of Thai learners. Ghaleb et al. (2006) put forward the research works in the field of e-Learning and also discussed the various applications of e-Learning, like virtual classrooms, distance learning and remote classrooms. Rene et al. (2011) proposed that ontology can be used in e-Learning to organize the teaching resources semantically by identifying the relationship between the materials, thereby improving the quality of teaching resources. Raymond et al., (2009) discussed that, with the extensive applications of electronic learning (e-Learning) technologies to education at all levels, an increasing number of online educational resources and messages were produced from the corresponding e-Learning environments.

The major differences between the proposed techniques with the existing techniques are discussed here. The work presented in Dutta (2006) provides the semantic web-based architecture for e-Learning. But, in the proposed technique, the retrieval of e-Learning contents is improved with the help of a semantic measure. In Snae and Brueckner (2007), the semantic e-Learning is developed for Thai learning environment. Here, the user profile-based learning environment is considered. The work presented in Ghaleb et al. (2006), Rene et al. (2011), Raymond et al. (2009), uses single ontology for providing the suitable contents or organizing the e-Learning contents. The proposed work aims in extracting resources from multiple ontologies using a semantic similarity measure thereby improving the retrieval of learning contents.

The paper is organized as follows: The second section provides models and expectation. The third section describes the methods utilized for the proposed e-Learning system. The fourth section deals with results and performance evaluation of the proposed approach under different criteria. Finally, fifth section discusses about the practical implication and sixth section concludes the paper with the scope for future enhancements.

2. Model and expectations

On considering the above discussed methods and their features, a new method is proposed to improvise the e-Learning system. The proposed approach is a concept similarity method, which is used to compare the similarities between the concepts in the different ontologies. The two different ontologies considered here are the fuzzy domain ontology and the Domain expert's ontology. The proposed approach deals with extracting details by comparing the concepts between the ontologies. The concepts are extracted from the concept map of the ontologies. A concept map is automated from the fuzzy domain ontology and a concept map is manually developed by experts with the help of domain expert's ontology. An XML file is generated based on a particular concept, which contains the representative and property set of the specific concepts from the ontologies. The representatives and properties are then processed for the generation of the concept similarity measure. The concept similarity measure is the main factor, which defines the most relevant concepts for the user according to the input query.

The main contributions of this paper are as follows,

- The use of more than one ontology, since most of the e-Learning system works with only a single ontology.
- The concept similarity measure, which we designed in the proposed method stands as the signature to the proposed method. The concept similarity measure is used to find related concepts from the different ontologies.
- The other feature in the proposed method is the user personalization for the e-Learning content. The model describes the user best knowledge and the information unknown to the user.

3. Methodology

3.1. Ontologies used in the proposed e-Learning system

In the current scenario, the ontology is considered as the hierarchy of concepts, which is a part of the concept map. The e-Learning systems (Zheng et al., 2013; Chikh, 2013;