Designing ontology-based academic course for ‘Theory of Computation’ to facilitate personalized e-learning system

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ABSTRACT

The increasing awareness of e-learning with aid of reusable ontology led to partial development of ontology for few subjects. Ontology aids to organize the structure of information on the basis of commonly accepted vocabulary among the researchers, these can be accessed via software agents applying semantic web concepts. This reusability saves the instructor’s time to make use of already build ontology via integration and merging. The main goal of e-learning environment is to present content in efficient manner for improving learner’s performance and their interest of learning. Many educational researchers had acknowledged interconnection involving the learning style and the performance of learner, as compared to the perspective of conventional classroom environment. This Paper makes use of widely accepted Peter Honey and Alan Mumford learning style model to group learner (personalized) and on the basis of learner’s learning style the content of subject named Theory of computation (TOC) is provided applying semantic inference rules. The ontology for TOC subject has been developed using Protégé 4.2 alpha tool.

Keywords: Ontology, Semantic web, software agent, e-learning, inference rule.

1. INTRODUCTION

The Internet has doubled in size every year since 1969; current statistics of internet user across the world has crossed the two billion. Internet revolution and advancement in semantic web approach led to adoption of web based learning system. E-learning based on semantic approach serves in imparting educational goal with objective of utilizing the student inherits characteristics. Semantic web integrates heterogeneous data, facilitates interoperability and provides service for optimized querying, searching and navigation [1]. One important component of semantic web is ontology that is study of existence [2]. Ontology defines a common vocabulary for researchers who need to share information in a domain [3]. It includes machine-interpretable definitions of basic concepts in the domain and relations among them. The W3C standard for Semantic Web includes OWL (Web Ontology Language) and RDF (Resource Description Framework).

Several issues like “teacher bandwidth”, i.e. the number of learners a single instructor can successfully mentor, have been primary bottleneck in conventional learning system [4]. Also in traditional approach the same course content is delivered to all kind of learner neglecting individual’s learning style. In current scenario one’s knowledge is accredited on the basis of evaluation result. Nevertheless performance upgrade is essential for academic and professional front. Learning style reflects the unique preference of an individual towards receiving grasping the newly processed information and later ability to recall and organize those data. These problems can be addressed by e-learning environments, which is capable of supporting a one to one communication [5]. Many educational researchers had acknowledged interconnection involving the learning style and the performance of learner, as compared to the perspective of conventional classroom environment.

In this Paper ontology upper layer ontology has been proposed for Theory of Computation (TOC) course that is being taught in undergraduate program in engineering field. This Paper draw upon Peter Honey and Alan Mumford Questionnaire, which is based on Kolb’s learning style model, for grouping the learner style (personalize) and present the personalized content based on inference rule. The ontology for TOC subject has been developed using Protégé 4.2 alpha tool.

2. RELATED WORK

Kolb’s [6] provided relatively flexible account of learning styles claims that concrete experience and abstract conceptualization reflect right- and left-brain thinking respectively. The right brain is supposed to be initial receiver of all information and it globally processes. The left brain is in charge of language and speech production, it processes the information sequentially and those in which this part is dominant are highly structured logical and organized.
Kolb’s Learning Style Inventory (LSI) comprises of four categories: -The converging style (abstract, active), the diverging style (concrete, reflective), the assimilating style (abstract, reflective) and the accommodating style (concrete, active). The converging style relies primarily on abstract conceptualization and active experimentation, they are good at problem solving, decision making and prefers dealing with technical problems rather than interpersonal issues. The diverging style is imaginative and aware of meanings and values. The assimilating style likes to reason inductively and to create. The accommodating style likes doing things, carrying out plans.

Felder-Silverman [7] proposed four dimensions of learning styles viz. active-reflective, sensing-intuitive, visual-verbal and sequential-global based on information processing model of the learner. An individual can check their learning style based on Felder and Solomon [8] which consists of forty-four questions each of having four alternative answers.

Honey & Mumford [9] proposed four learning dimensions named activists, reflector, theorist and pragmatists. The activist group are open minded and enthusiastic, reflectors prefers to observe and takes time before reaching conclusion, theorists are logical whereas pragmatists prefers to solve practical problems and ready to try new ideas.

Two set of questionnaires i.e. 80 item versions and 40 item versions has been proposed. The first type comprised of is 20 questions per style and is supposed to be suitable for longer session of interaction and feedback with learner. Whereas 40 item version has 10 questions for each style and it is suitable for short term learning session, as few suggestions has been designed for action as compared to aforementioned questionnaire.

Md. Tanvir Uddin Haider, Aditya K Sinha and Banshi Dhar Chaudhary [10] have proposed about the interconnection between academic deficiency and learning style of learner in traditional education system. The results were based on result and statistics of experiment conducted for end-semester exams and online quizzes. This work makes use of Felder-Silverman learning dimensions.

The design and prototype implementation of an adaptive e-textbook for Theory of computation course by using ActiveMaths has been proposed by Eric Andr’es, Rudolf Fleischer and MinEr Liang [11]. ActiveMaths provides mathematical environment for technology enhanced learning on the web. The performance of the learner is checked with various feedback like homework, quizzes, background knowledge and feedback.

Ling Jiang, ChengLing Zhao and Haimei Wei [12] have proposed ontology for computer network based on Topic Maps. TM4L software has been used to browse and create educational topics. Ontology for Software Engineering has been proposed by Yajing Zhao, Jing Dong and Tu Peng. This paper work enumerates some benefits of ontology to critical issues related to various domain of approach in Software engineering domain.

José R. Hilera, Luis and Fernández-Sanz [13] have proposed domain ontology based on IEEE glossary of software engineering. In this paper CMMI level domain has been categorized into concepts (class).

An architecture of e-learning system based on Dunn and Dunn learning style has been proposed by Christian wolf. Multimedia learning and adaptive hypermedia environment has been taken into consideration for presenting the content matter.

Zhang jinghua [14] has proposed personalized learning for programming course. The SWRL rule has been used for standard representation and automatic reasoning

3. METHODOLOGY

In this Paper, ontology for Theory of Computation (TOC) course that is being taught in undergraduate program in engineering field has been proposed. In this work the content for Theory of computation course is being provided automatically applying inference rules of semantic web, on the basis of Learner’s learning style. To test the style of learning Peter Honey and Alan Mumford Questionnaire, which is based on Kolb’s learning style model has been used.

The proposed approach will help to identify the learning domain of learner’s which will help the instructor to build the more suitable instruction process. It will also help to enhance the performance of individual learner by making interesting, motivating, interactive, and feedback session and aids for on demand learning approach which would motivate learners to pursue higher education.

4. ONTOLOGY DESIGN

In this Paper, work has been focused on the limited content matter of the subject focusing on the types of Automata, Types of grammar, formal languages and their properties. This layout has been derived by considering the sequence from book titled “Introduction to Automata theory, Languages and Computation” [15]. The ontology has been developed using Protégé 4.2 alpha.

Figure 1 show the snapshot of ontology for Theory of computation developed on the protégé interface. Thing is inbuilt super class provided by the protégé tool. Topics like Automata, Formal languages and Grammar , which are major domain of this subject has been partitioned into classes and further branching based on relevance has been developed on the basis of content taken from “Introduction to Automata Theory, Languages and Computation”. For instance Finite automata, linear bounded automata, pushdown automata and Turing machine are four types of automata.
Figure 1: Screenshot of TOC ontology on protégé interface

Figure 2 shows the Ontograph view of TOC ontology. Ontograph is ontology visualization plug-in for protégé. This interface displays the concept (class) and their hierarchy in various forms like spiral, grid horizontal and vertical tree structure. This view helps to give a graphical aspect of the proposed ontology without showing their underlying relations name (like is subclass of). This view aid to give clear ideas and is very handy when there are numerous topics involved for larger application. This view is horizontal tree structure of the proposed ontology for Theory of computation course.

Figure 2: Ontograph view of TOC ontology

Figure 3 shows the Owl Viz view of TOC ontology. Owl viz is also a plugin environment compatible with protégé. It is an owl visualization tool which displays the class hierarchy graphically and helps to navigate them. This view helps to
generate the graphical structure of ontology content along with is-a relation for class and subsequent sub class in the hierarchy.

Figure 3: Owl Viz view of TOC ontology

Figure 4 shows snapshot of partial OWL code generated in protégé tool. The upper layer ontology designed is represented in OWL, which is accepted as the standard by W3C. The generated code is machine understandable and its structure of tags resembles with XML, as Owl is based upon XML and RDF concepts. Inference rules could be used to deduce the desired result for indexing and searching.

Figure 4: Snapshot of owl code in protégé interface
5. SCOPE & LIMITATION
Scope of the Paper is limited to e-learning domain. Upper layer ontology has been proposed for important topics of the subject like the types of Automata, types of grammar, formal languages and their properties. Many other issues like aberration from detected style, changes in style based on ages e.g. have not been taken into account.

6. CONCLUSION
With economical and easy access of web resources via internet, both government and many educational institutions worldwide are giving emphasis on e-learning to attain the goal of global knowledge. This work is an effort to design personalized e-learning system for Theory of computation (TOC) by making use of learning style concepts and semantic web technology. The proposed approach will help to identify the learning domain of learner’s which will help the instructor to build the more suitable instruction process. It will also help to enhance the performance of individual learner by making TOC course more interesting, motivating, interactive, and feedback session which aids on demand learning approach to motivate learners to pursue higher education.

1. FUTURE WORK
The proposed work is in its early stage of development. The scope of further improvement on ontology optimization could be everlasting area. Further works includes making inference rules based on the learning style of learners. Rules could be used to interlink upper layer ontology and corresponding data source on the fly. A more improved version of work would comprise of all the dimensions of Honey and Alan Mumford’s learning style. Further works includes making inference rules based on the learning style of learners. Rules could be used to interlink upper layer ontology and corresponding data source on the fly. A more improved version of work would comprise of all the dimensions of Honey and Alan Mumford’s learning style. Further works includes making inference rules based on the learning style of learners. Rules could be used to interlink upper layer ontology and corresponding data source on the fly.

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