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SW-EL'05: Applications of Semantic Web Technologies for E-Learning

AIED 05 Amsterdam WORKSHOP

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SW-EL'05: Applications of Semantic Web Technologies for E-Learning

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Posters

Ontology as a Foundation for Knowledge Evaluation in Intelligent E-learning Systems

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Abstract. Services on WWW have enabled development of the e-learning systems which are considered to be direct application of the information and communication technology. The xTEx-Sys system is a Web-based authoring shell with adapted environment to each actor of the system. A formal representation of the course material in the xTEx-Sys involves ontology driven knowledge description. Student's knowledge evaluation in the xTEx-Sys is realized by using dynamic quizzes. This paper describes the ontology's role of the xTEx-Sys knowledge evaluation process.

Introduction

Information and communication technology combined with multimedia, networking and software engineering, have enabled the development of new learning and teaching environment. The last great milestone in this environment was an introduction of the Internet and WWW, and it was expected that all educational systems are to be reengineered. The usage of those technologies enables the development of the Web based authoring shells for constructing the Web oriented intelligent tutoring systems (ITS). According to ITS traditional modular architecture [1] and the idea of the cybernetic model of the system [2, 3] we have developed an intelligent hypermedia authoring shell called the Tutor-Expert System (TEx-Sys) [4]. We have created our own learning and teaching model as well as scenario for the knowledge evaluation by using knowledge bases developed by the TEx-Sys. Nowadays our work is directed on the implementation of a prototype of the extended version of the TEx-Sys, the *eXtended Tutor-Expert System*, xTEx-Sys [5], within a technology project founded by Ministry of Science and Technology of the Republic of Croatia. The xTEx-Sys is an authoring shell with an environment adapted to an every actor of the system: (i) an expert to design the domain knowledge on specially defined ontology for the knowledge representation, (ii) a teacher to design courseware using defined ontology for hierarchical organization of course content on *units, lessons, topics* and *instructional items* for student learning and teaching process as well as *tests of quiz type* for the student knowledge evaluation (the courseware structure elements), (iii) a student to select course and navigate trough the domain knowledge content via didactically prepared course content and (iv) administrator for the system supervision. Scenario for the student knowledge evaluation is of a great interest to us during the TEx-Sys and now with the xTEx-Sys research, implementation as well employment. Supported by our previous experience, a new knowledge evaluation method, based on dynamic quiz, is designed. The structure of knowledge representation in the TEx-Sys points out a motivation for enhanced approach to specially designed didactical ontology. The xTEx-Sys domain knowledge representation is based on OWL Web Ontology Language [6] and such representation makes foundation for teacher's and student's view of the knowledge evaluation process described in first section. Concluding remarks are given in second section.

1. Knowledge Evaluation

Student's knowledge evaluation in the xTEx-Sys is realized by quizzes. Quiz is an implementation of the test where the student gets a set of questions with attached answers which can be correct or incorrect. The teacher is responsible for assigning quizzes in course. Dynamic quizzes, which are generated by the xTEx-Sys, are often used for the fast evaluation of student's knowledge. This kind of quiz has questions structured on queries about concepts and relations.

Dynamic quiz generates questions over some domain knowledge. Considering OWL syntax for the knowledge representation, queries about concepts are translated into questions about classes or individuals, while relations in questions are expanded with properties as a special kind of relation (see Table 1). The xTEx-Sys dynamic quiz has three question categories of different levels of difficulty.

Table 1. Categories and questions in dynamic quiz

1st category	2nd category	3rd category
Recognize class/individual!	What is class/individual?	What are the properties of class?
What kind of relation is between two classes/individuals?	Who is in relation with class/individual?	What is value of individual' property?
Does class has property?	What relation is between two classes/individuals?	Who is and how in relation with class/individual?
Are two classes/individuals in relation?		

The first category contains the easiest questions, third category contains the hardest questions and the questions of middle difficulty level are in second category. Process of the knowledge evaluation can be observed from both the teacher and student point of view. The teacher, as a courseware designer, has to define when the students are to be tested. He prepares starting point for the knowledge evaluation which is performed by the student. In the following, algorithms and tasks from the teacher and student's viewpoint are described.

1.1 Teacher's View of Knowledge Evaluation Process

Test, as part of courseware content, can be created almost in any aggregation of learning objects. Generally, the first condition that teachers meet, while building course, is the existence of domain knowledge. When a teacher wants to publish a test, he must select one aggregation from the set of courseware learning elements, which will hold newly added learning object with a testing functionality. After entering the name of the learning object, the system calculates possible number of question series. In the case of dynamic quiz, chosen aggregation must have at least one learning object because questions are generated over some subset of domain knowledge assigned to aggregations' learning objects. Calculation for proposing amount of question series is based on the number of distinct domain knowledge elements gathered from all learning objects in the same aggregation where test will be put. An algorithm for proposing number of possible question series will count these elements of the domain knowledge: C – *the classes count*, I – *the individuals count*, R – *the relations count*, P – *the properties count*, M – *the media properties count*.

For every dynamic question, a minimum of dynamical generation condition has to be defined. If we look, for example, at the second question type "Are {Class/Individual1} and {Class/Individual2} in relation?" we can see that it is assembled from non changing question text as well as of a dynamic text placeholders. In this template, {Class/Individual1} and {Class/Individual2} are two dynamic text placeholders which are in a process of testing, and

what is more filled with name of randomly chosen class or individual. However, answers can also have placeholders, but this template has constant text values which are: (i) No, (ii) Yes, directly and (iii) Yes, indirectly. For this type of question, the number of relations' count (R) has to be above 1 to generate question with "Yes, indirectly" as a correct answer. Moreover, the number of classes/individuals (C+I) has to be greater or equal to 2 so that the question could include two concepts. These two conditions make a minimal dynamical generation condition for that question type. Quiz in the xTEx-Sys must have at least one question type from every category. The minimal dynamical generation condition for category of questions is made by combining minimal dynamical generation conditions of every type of question in that category. Consequently, the minimal condition for the dynamic quiz generation includes minimal conditions of every category.

If minimal condition for dynamic quiz generation is satisfied, then the maximal possible number of question is a minimum of a set of maximum number of generated questions for each question types. For example, the second question type has the minimal conditions R>=1 and (C+I)>=2, so maximal number of generated questions has to be min{R, C+I}. Finally, when all maximal number of questions for every type of question is calculated, then the maximal number of questions that could be dynamically generated in quiz is a minimum of all maximal number of questions that can be generated for each type of question. That number is presented to the teacher; therefore he can select less or equal value of questions for his newly created test.

1.2 Student's view

Afterwards when student selects testing, the system initializes the process of dynamic quiz question's generation and presentation. Dynamic quiz generation in the xTEx-Sys means run-time creation of question text and answers over prepared set of the domain knowledge elements. If there is going to be generated question based on the second question template then algorithm is randomly choosing knowledge domain elements according to the placeholder's requests for particular domain knowledge element (Figure 1).

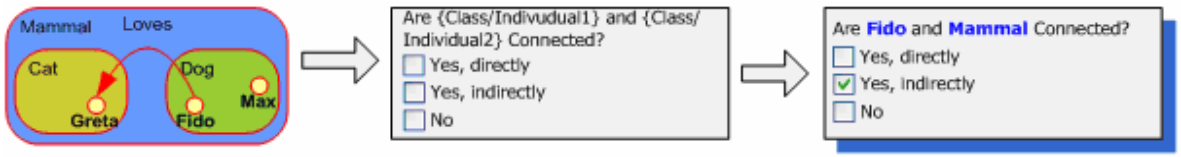

Figure 1. Process of question generation

When a student starts the dynamic quiz, the initial level of difficulty of a problem is sent to the problem generator. According to this difficulty level, the system generates pair of questions and sends it to the student. The first pair consists of two questions from the second category. After solving that pair of questions, the student submits his answers which are going to be evaluated, giving thus partial results of the test. These partial results are used by the system and have a very significant role. The problem generator, according to these partial results feedback, decides from which difficulty category will be the next pair of questions distributed to the student (Figure 2) or, in the worst case, violently interrupts testing and gives unsatisfying mark.

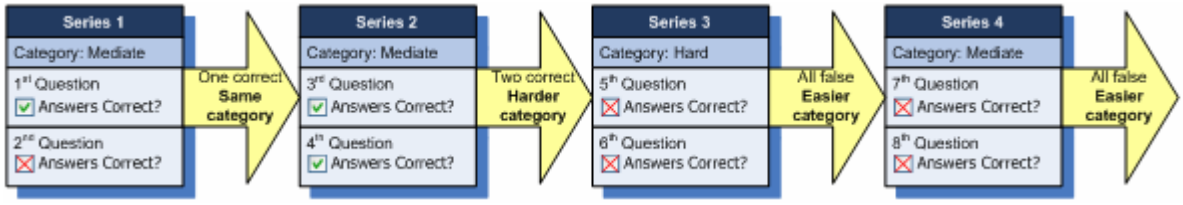

Figure 2. Category shifting in dynamic quiz

After the last series of questions, the overall result is estimated on the basis of calculating the final mark according to the relation between accomplished points and the maximal possible points. Calculated mark varies from an unsatisfying to an excellent. Presenting the result of the test involves not only displaying final mark, but also it gives back set of correct answers as well as the question category sequence. Therefore, the student can actually see where s/he was wrong and afterwards choose concept or relation to see exactly where, how and why s/he had made a mistake.

2. Conclusion

The Web Ontology Language, as a specification for the domain knowledge representation in the xTEx-Sys joins characteristics of network-based and logical-based knowledge representation. By uniting these major approaches to the knowledge representation, the domain knowledge in the xTEx-Sys provides quite good expressive power and computational costs. Ontology as a foundation for knowledge evaluation emphasizes dynamic quiz potential in the process of student testing. From teacher's point of view, the process of defining tests for a student is facilitated to the level where teacher only has to enter the name of the test and choose number of question cycles. At the other side, student will probably never be asked the same question during knowledge evaluation, and the question heaviness will vary depending on the student's correct answers.

Comparing preliminary test results of the xTEx-Sys system usage with results of the TEx-Sys we can say that student's feedback is quite positive in many ways. Major and the most important difference is readability of learning content which implies better understanding of the test questions. The second important difference is a refined user interface and simplified functionalities that make system friendlier and easier for usage.

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References

[1] Burns, H., Capps, C., Foundations of Intelligent Tutoring Systems: An Introduction., in M. C. Polson, J. J. Richardson, Eds.: Foundations of Intelligent Tutoring Systems, Lawrence Erlbaum Associates Publishers, 1988, pp. 1-18

[2] Pask, G. A Cybernetic Model of Concept Learning. Proceedings of 3rd. Congress International. Assoc. Cybernetics, 1961.

[3] Božičević, J., Fundamentals of Automatic Control, Part I – System Approach and Control, 10th Edition, Zagreb: Školska knjiga, 1980 (in Croatian).

[4] Stankov, S., Isomorphic Model of the System as the Basis of Teaching Control Principles in an Intelligent Tutoring System, PhD Diss, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Split, Croatia, 1997 (in Croatian)

[5] Stankov, S., Principal Investigating Project TP-02/0177-01 Web oriented intelligent hypermedial authoring shell, Ministry of Science and Technology of the Republic of Croatia, 2003-2005.

[6] xxxx: OWL Web Ontology Language Guide, W3C Recommendation, 2004, http://www.w3.org/TR/2004/REC-owl-guide-20040210/