SeMCQ – Protégé Plugin for Automatic Ontology-Driven Multiple Choice Question Tests Generation

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Introduction

Creating fair and meaningful assessment strategy is one the most difficult areas for every educator. Objective (MCQ) testing has been extensively studied and evaluated as a method for formative and, to a lesser extent, summative assessment. While the objective tests need to be complemented by other assessment strategies in order to assess higher cognitive domains, they nonetheless provide important benefits that are directly addressing the student needs such as, providing prompt and frequent feedback (2008 UK National Students Survey [8]). Moreover, in its more advanced forms, such as Computer-Adaptive Testing, objective tests can "get closer to measuring skills and intelligence" [3]. However, creating a useful objective test is not only difficult but also very time-consuming, which prevents its more wide-spread adoption and use [1]. In this paper we are trying to address this problem, by providing a framework and a prototype of a Semantic Multiple Choice Questions (SeMCQ) generator for an arbitrary knowledge domain. The prototype is implemented as a Protégé plugin. In the following sections we describe the implementation details of the prototype as well as some areas of future work.

Use cases

The envisioned target framework is presented to the end users as a Web service. It provides users with a variety of questions generated based on different ontologies. Future versions of the system will incorporate semantic web services as well as search results from semantic web search engines. In addition to simple answering a set of generated questions, user may adjust difficulty level of the question set. Also, user can include non-semantic web content such as multimedia and multi-language content. The user may or may not be registered. If registered, the user is provided with personalization of the learning services. For example, question answering statistics is memorized for later use, comparison to other students is provided for the student's reference, synchronous as well as asynchronous knowledge competitions are organized, etc. The developed SeMCQ prototype implements MCQ representation and ontology driven generation. It is a proof-of-concept for the proposed approach.

System architecture

The overall conceptual system architecture is organized around the following five modules:

(M1) MCQ generation – this module contains heuristics, algorithms and rules for generation of MCQs based on a given domain ontology. For the purpose of the prototype, we base our development on work presented in [7]. We particularly focus on features of the selected domain ontology that have the strongest influence on the quality of the generated questions. One of the features is absolute ratio of the number of instances/classes/properties in the ontology, second is their relative ratio, etc. **(M1-1) MCQ enhancement** – Generated questions are usually featured with considerably low quality of the used language. For the questions language improvement we can use several existing NLP techniques, including Web search for sentences that provide the best interpolation for the generated questions. Another approach, suggested in [5] is to use question templates.

(M2) MCQ Ontology – this ontology is used for development of the MCQ format specification and it serves as an adapter between the original domain ontology and the application GUI **(M3).** The MCQ ontology is populated by question instances generated in **(M1).** There is at least one XML-based standard for MCQ format specification [6] that is a good starting point for our purposes. For the purpose of the prototype, we manually translate the XML description into the Protégé ontology, while, in future we may

proceed by adapting the XML2Protege plugin for automatic generation of ontology from an XML specification.

(M3) Application GUI (XHTML/Ajax/Flesh) generation – this module is based on a graphical user interface ontology. The GUI ontology is then mapped into the previously defined MCQ ontology.

(M4) Application management – For this module, we need to define application/system management ontology. It would integrate M1, M2 i M3 in order to support multiple students groups, different institutions, different instructors, etc. Further, end-user Web application would be generated using this ontology.

Current version of the SeMCQ prototype implements a portion of the envisioned framework. Within the scope of the module M1, we developed a first simple version of the MCQ ontology. Initial implementation of the module M2 included strategies for question generation from [7]. Based on the practical experience with the ontologies available on the web, we were able to introduce some optimizations in the question generation strategies. NLP is implemented in the M2-1 module in a very rudimentary form and represents one of the most important objectives of our future research. User interface on the client side is Flex-based and is under active development migrating towards automatic code generation. Within the application management module, we just scratched the surface by development of the Role Based Access Control (RBAC) ontology for access rights management within the system.

Conclusions

While the results of the objective tests might not always be used to evaluate "deep learning" they certainly form a useful base and can be used as a "seed" for further assessment enhancements. The prototype can be used in a context of a personalized learning environment based on high quality knowledge formalized in a form of ontology [4], [5]. In addition to implementing the full-scale system described in the previous section, in future work we aim to increase the quality of generated questions by using question templates [5], introduce new types of questions [2], provide generic feedback, and extend the system with "adaptive tests" [3]. In parallel with the development, we plan to test the usability of the developed system, with selected groups of students from University of Hertfordshire and University of Nis, starting in Sem A 2009/10.

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