GYM-Author: Generation Of Self-Learning Exercises In Philosophy

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Abstract

Can a system have the ability to dynamically generate, on demand, a large number of adequate exercises in order to feed a learning environment in philosophy? We addressed this issue with our *Philosophical Gymnasium*[1] (Phi-GYM) project with its authoring tool. Our motivation in designing the authoring tool was to: (1) Find an effective way to provide a wide range of exercises, and to; (2) Provide Philosophy teachers with an easy, autonomous, and collaborative way to create exercises related to classical Philosophical texts without worrying about technology. After a brief review of related work, this article describes the design and development of the *Philosophical Gymnasium*'s web-based authoring system[2], which semi-automatically generates self-learning exercises in the philosophical domain for a web-based learning environment (the *Gymnasium*'s second component). We conclude by presenting our plan about GYM-Author's performance evaluation and deployment plan for scaling the system.

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[1] Known in French as "*Le Gymnase Philosophique*".

[2] The *Philosophical Gymnasium* has two components, the authoring system described in this paper and which we call "GYM-Author" and the *Gymnasium*'s learning environment proper, which we call "GYM-Tutor" and which is still in development.

Author Keywords

Collaborative authoring system; Semi-automatic exercise generator; Philosophy; Teaching Philosophy; Web-based authoring; self-learning.

Introduction

Online education aims at providing leaning opportunities for thousands. Thus, the rapid and easy production of courses and pedagogical material that respect well-attested educational paradigm and learning design principles in a given field is essential to insure the pedagogical quality of massive online open courses. In this context, the Government of Quebec undertook to fund innovative technologies that facilitate the quick and easy production / dissemination of open, online, self-learning material (in various fields) to make it freely available to the largest number of students across Quebec. Thus was born the metaphor that inspired the *Philosophical Gymnasium* project: this research project aims to facilitate, through a web-based learning environment, the practice of the various intellectual gymnastics needed by college[3] students who, in Quebec, all have to read and write philosophical texts. The first important issue that we addressed and which led to the development of the authoring system was: How can our system have the ability to dynamically generate, on demand, many adequate self-learning exercises in order to feed the learning environment planned for the philosophical domain? Our motivation in designing our authoring tool was:

1. Find an effective way to continuously update our learning environment in order to provide a wide range of exercises to the Philosophical Gymnasium's users (typically students in Philosophy).

2. Provide Philosophy teachers, who have varying degrees of computer proficiency and who are distributed across a vast territory, with an easy, autonomous, and collaborative way to create questions related to classical Philosophical texts, allowing them to focus only on their philosophical content (the teachers domain of expertise) without worrying about technology.

We believe this work is original in that there is currently no web-based authoring system for generating semi-automatically self-learning exercises in the Philosophical domain for a web-based learning system. After a brief review of related work, this article describes the design of the GYM-Author with an emphasis on its semi-automatic generation and collaborative functions. We conclude by giving our future plan about GYM-Author's deployment and scaling.

Related work

The late 90s saw AIED[i] research community get more and more interested in authoring systems, and even started to classify them ([1]; [2]), as they addressed the problem of generation of learning material. Authoring systems do not support learning itself: their purpose is to support the design and generation of learning material (from, e.g., questions, exercises, all the way to learning environments, intelligent tutoring, and so on) for the learning environment, and, often, to provide means to generate this learning semi-automatically even automatically. Our work builds on two related threads in this area of research: (1)

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[3] The « College » level in Quebec stands between the high school (grades 7-12) and university levels.

Paradigm-specific authoring tools, (2) Exercise generation tools.

1.1 PARADIGM-SPECIFIC AUTHORING TOOLS

As stated by Mitrovic and Koedinger in their preface to the IJAIED Special Issue on Authoring Intelligent Tutoring Systems, "*The presented authoring systems ease the development process by automating a variety of authoring tasks, such as interface design (CTAT and ASPIRE), knowledge acquisition via machine learning (ASPIRE), supporting the author in developing the cognitive model (SDK) or their teaching strategy (SMARTIES) and supporting the development of tutoring systems with no or minimal programming required (ASPIRE and CTAT)*" [3]. All of these issues are of great importance for tutoring systems, and can help bring the area a step closer to achieving widespread use of ITSs. Moreover, as highlighted by Nkambou, Bourdeau and Psyché (2010), "*the current R-D practice is to develop building tools that are paradigm-specific (Kodaganallur et al. 2005) [...]. Using a "backbone," teams built tools that allow for derivation and "variabilization,". [...] Thus, recent developments show a "specialization" by paradigm, discipline of reference and privileged application domains, resulting in a similar specialization in the authoring tools that are derived from them. At the same time, some new web paradigms are becoming good metaphors for collaborative authoring generally. For example, an open authoring model inspired by Wikipedia seems to be quite appropriate in the ITS context (Aleahmad et al. 2008)*".

In our case, GYM-Author is a web based collaborative and pedagogy-oriented authoring tool. Its paradigm is based on a constructivist view of reading and writing strategies. Its domain of reference is the humanities, and especially Philosophy, a domain where much of the learning is made through the reading of classical texts, often written hundred and even thousand years ago, and by producing written texts about these classical texts (either about the texts themselves or about their content). Its privileged components are the pedagogical and the learner models. Finally, its main application (for the moment) is in the domain of Philosophy. We will explain each of these statements in the next sections.

1.2. EXERCICE GENERATION TOOLS

We follow Cablé, Guin and Lefevre's (2013) classification of exercise generators into three categories: (1) automatic exercise generators; (2) manual exercise generators; and (3) semi-automatic exercise generators; where systems such as APLUSIX belong to the first category, systems such as GenEval belong to the second category, and GEPPETOp and systems such as CLAIRE belong to the third and last category. Automatic generation is very time efficient if one is looking for massive creation of exercises without any pedagogical constraints. At the opposite, manual generation of exercise give authors all the flexibility needed, but is very time consuming. Moreover, we notice that when given too much learning design choices, author often get lost.

As highlighted by [4], "*semi-automatic generators of exercises combine the advantages of [the automatic and manual] classes of generators*", which is why we chose to design GYM-Author to be a semi-automatic exercise generator. We believe them to be the most adaptive and they fit one of our primary goals to help teachers in a more efficient way.

3. SYSTEM DESIGN OVERVIEW

3.1. ARCHITECTURE

The Fig. 1 show the architecture of our authoring with an emphasis on the tools (exercises generation and collaborative authoring) describe in this article.
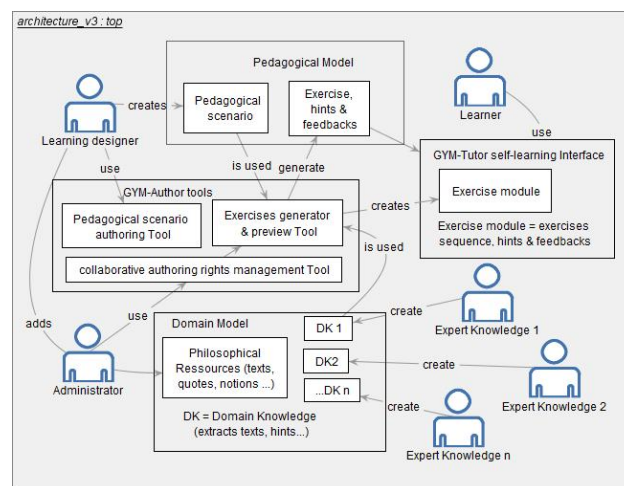

Figure 1. GYM-Author architecture

The next two sections present in detail these tools.

3.2. A SEMI-AUTOMATIC SELF-LEARNING EXERCISE GENERATION TOOL

The GYM-Author provides many roles to the teachers; our interests here are the *learning designer role* and the *knowledge expert role* (Fig. 1). The learning designer is responsible for the edition of various pedagogical scenarios according to the objectives and for contexts of learning. The knowledge expert is responsible for creating contents and exercises in Philosophy following to a predefined pedagogical scenario. In practice, these roles are often both played by the Philosophy teacher, according his or her level of expertise.

For instance, while using our authoring tool, knowledge experts in Philosophy will not have to think about the structure of the implicit pedagogical scenario (i.e., *implicit* for the knowledge expert but not for the learning designer) that supports the whole system and, because of that, they will be able to focus on the content of the exercises. But, our system provides the opportunity for any Humanities teacher, as knowledge experts in their own field, to create their own pedagogical scenario AND contents, since they can get the permission from the *Gymnasium*'s main administrator to be a learning designer as well as a content provider. The only part that will be invariable are the type of question offered such as *True/False* (T/F), *Multiple Choice Question* (MCQ), *Tagging*, *Cloze test* and *Brief Answers*, that fits in the pedagogical scenario that will be designed. However, we have designed the *Philosophical Gymnasium* so that it can support most type of exercises relevant for learning in the philosophical domain. Fig.2 summarizes all the interactions which can be performed by the teacher while creating and generating exercises.

3.2. A COLLABORATIVE AUTHORING TOOL

GYM-Author is also a collaborative system (Fig. 1). First, the fact that all teachers registered as Phi-GYM knowledge experts provide the contents that is available to students in the public part of the system (the GYM-Tutor learning environment) is at how within the collaborative paradigm. Second, each and every pedagogical scenario, whether designed by a learning expert or another teacher (with proper permissions – see above Fig.1), will also be available to all the other

teachers to add to it (or propose corrections to it) as one would in the *Wikipedia* model. For instance, an ethics teacher might want his/her own scenarios and decide to create one especially for his/her class. That scenario will then be available for all the other teachers, to design their own exercises on classical texts they perhaps favor more, and so on. But it will also be possible for that ethics teacher to only use the GYM-Author to create exercises, without having to think about the pedagogical scenario that sustains them.
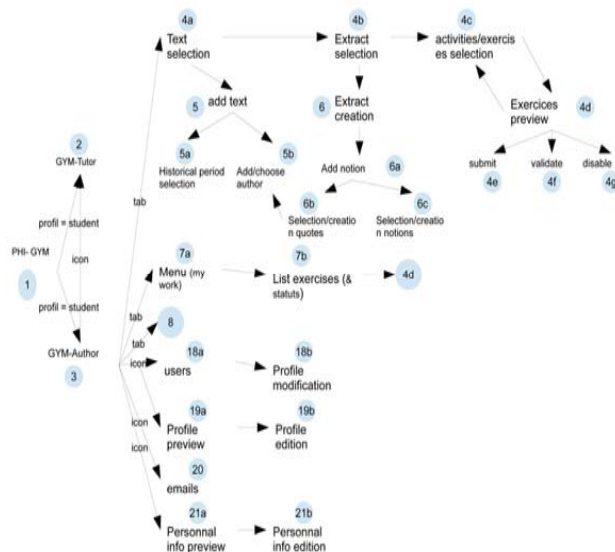

Figure 2. All the possible interactions performed by the teacher in GYM-author

Performance testing

Background and Motivation
The GYM-Author is designed to be used for free by multiple users simultaneously and at different scales in order to create exercises to feed the GYM-Tutor.

Technical Specifications. The GYM-Author (client) is hosted on a research dedicated server with four processors clocked at 3.8 Ghz, 4GB RAM, 830Go on a RAID5 based storage unit and a high bandwidth of 1Gbps warranty. In addition, the GYM-Author uses simple computing treatments such as database queries with data transmissions such as long strings and occasionally thirty seconds audio files, in addition to the display of these data on its interface. It is important to ensure that the use of GYM-Author, even in extreme cases, is not a major risk, although its use is less frequent and require fewer resources than the GYM-Tutor, which will be used by a larger number of users.

Scalability Hypotheses
Considering that the GYM-Author will be widely used throughout Quebec or abroad, we defined several scalability hypotheses according to the propagation of the use of GYM-Author. We build on the fact that there are about fifty francophone Colleges in Quebec who have on average ten teachers in philosophy. In the first case, we suppose it actively used by one user at a time. In a second case, we suppose it actively used by about ten users simultaneously, which would correspond to one teacher for every five Colleges. In a third case, we suppose it actively used by hundreds of users simultaneously, which correspond to two professors by College for all Colleges. In the last case, we suppose it actively used by a half thousands of users, which would correspond to all teachers of all Colleges.

We can still suppose other cases, for example if the *Philosophical Gymnasium* manages to touch other francophone institutions and even to be translated and touch different languages, or to touch a field other than philosophy, as we expected.

Action Plan

Our plan is to measure the performance of the server that is hosting the GYM-Author and the software that is the GYM-Author.

- *Server performance*. The department responsible for security and maintenance of the server assured us that its current configuration widely meets our technical needs. Thus, tests on the server will not be a priority but will still be made in the context of software testing.

- *Software performance*. We planned to achieve two main tests. First, a test of performance degradation will be performed in order to find the critical points of the software and for each use case. Then we will perform a load test in order to test these hotspots and validate the adequacy of the system performance according to our scalability hypotheses, or beyond, while validating server capacity. We plan to look for free tools to automate these tests [5]. As well, more advanced performance tests will be done. These tests will be especially useful for the simultaneous use of the GYM-Author and the GYM-Tutor on a large scale, particularly regarding data transfer that occurs between these two elements of Phi-GYM.

Conclusion

In this article, we have presented an original work on a web-based authoring system for generating semi-automatically self-learning exercises in the philosophical domain for a web-based tutoring system. We have described the design of the GYM-Author with an emphasis on its semi-automatic generation and collaborative tools. Our future plan about GYM-Author's deployment and scaling has been summarized.

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i Artificial Intelligence in Education