Considering Model-based Adaptivity for Learning Objects

Adaptivity for Learning Objects: Adaptive Hypermedia and Simple Sequencing

Adaptive Hypermedia (AH) and IMS Simple Sequencing (SS) are different approaches but both intend to attain a similar goal: tailored content for learning, just as Abdullah et al. discussed in [1]. However, these two distinct approaches have their own merits and defects. For SS, it takes the conformity with learning objects (LO) as the prime principle, and thus become the main approach to achieve dynamic presentation under the paradigm of using LOs to wrap up learning materials. But due to the absence of explicit domain and user models, SS cannot perform adaptivity in terms of learners' cognition, such as prior knowledge, learning styles, etc. On the other hand, AH systems focus on constructing explicit models that represent various aspects of information related to decision making, such as user's prior knowledge, preferences, learning domain, pedagogical knowledge, etc. Therefore, AH systems could perform elaborate decision making based on these models. However, issues like interoperability and reusability remain challenging to researchers in the AH field.

Here we discuss and present our observation on the issue of *model-based adaptivity (i.e. AH-oriented approach) for learning objects*. That is, we will consider how to bridge the gap between the AH and LO paradigms as described below.

Why Models?

Why should we consider domain and user models for the LO paradigm? We illustrate the need with two points: (1) to support in-depth adaptivity with respect to learners' cognition (2) to apply technologies developed for intelligent tutoring.

First, an evident cultural difference should be noticed. AH systems take *cognitive effect* as the main concern. For example, *adaptive navigation support* aims to share learners' cognitive load and prevent learners from disorientation. To handle cognitive issues, appropriate domain and user models are necessary. Dependency relations of domain concepts, users' proficiencies on topics and users' behavioral patterns are fundamental information to be modeled in general. On the other hand, a typical LO paradigm does not address these issues much[1]. The presence of SS gradually changes the scenario. But SS still cannot perform adaptivity related to subtle cognitive effects due to the lack of corresponding models.

Second, model-based approach could benefit by various intelligent technologies. Some could be applied to LO paradigm seamlessly. A promising instance is to adopt course sequencing techniques to generate adaptive presentation in a systematic manner [4]. We will discuss this approach in the next section. Besides, it is also possible to apply machine learning techniques, e.g. theory refinement methods, Bayesian methods, etc. to automate the process of decision making [2]. Especially, when the scale of web-based learning is quite large, "hard-wired" sequencing rules employed by the SS approach might become inflexible and unmanageable. Instead of relying on the laborious process of authoring hand-coded sequencing rules, AI tools based on machine learning or data mining techniques would be hopeful to induce required knowledge as models.

Technical Issues

Though the areas of AH and LO are developed in parallel most of time, LO paradigm is not totally incompatible with AH systems. To achieve the integration, we notice two different situations: *LOs with or without SS*.

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[1] More precisely, SCORM focus on "ilities" not QoL (quality of learning) [7]

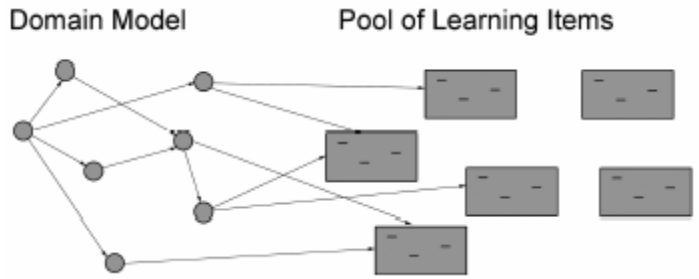

Figure 1. Bridging the gap between the domain model and learning items, adopted from [4].

	Global domain model & LO (without SS)	**Global domain model & SS**
Methods employed	*Domain model superposed*	*Domain model superposed*
Primitive learning item	*LO*	*Activity Tree*
Sensitivity	*High*	*Low*
Complexity of implementation	*Simple*	*Complex*

Table 1. The comparison of two kinds of integration.

If we purely consider LOs without SS, the integration is easier. It is possible to package learning items up as LOs in an AH system. Brusilovsky et al. illustrated the separation of domain model and learning items in Figure 1 [4]. Nodes of the domain model represent abstract pieces of domain knowledge, i.e. concepts, or topics. Materials to be taught and learned reside in the pool of learning items. By using this scheme, learning items could be wrapped as LOs without doubt. This approach will not change the characteristics that an LO should have, such as reusability and interoperability. In other words, we can still exchange and reuse individual LOs.

A much more complex situation is to consider LOs associated with SS. This type of integration of AH and SS is a relatively new direction. In [5], Chen et al. propose a global domain model to organize a group of activity trees. By analyzing prerequisites and contributed capabilities of each activity tree, the system intends to import more cognitive and pedagogical concerns into the SS approach. We observe that this approach could also be reduced to the scheme illustrated in Figure 1 conceptually, in which each "learning item" in the pool refers to an activity tree instead of an LO. However, constructing a global domain model to organize a crowd of activity trees may fall short in practice. Though there is no strict definition of what should be an "activity" of the activity tree, but the *granularity* of an activity tree is likely to be large enough as a complete course in general. Under this scenario, the power of superposing a global model on-top of activity trees seems relatively weak, because learners may not receive needed adaptation at the best time. The system could detect and give adaptation *only* after the learner finish a learning session—a whole activity tree. Before that, static sequencing rules determine every thing. In other words, the *sensitivity* of adaptation is related to the size of chunks (i.e. the granularity of activity trees).

The comparison of these two kinds of integration is summarized in Table 1. No matter which situation is considered, once the linkage between the domain model and learning items is established, we could use overlay modeling technique to represent learners' prior knowledge as a subset of the domain model. Furthermore, various techniques could be used to generate adaptive presentations adapted to learners' prior knowledge and goal.

Reusability of Models

It is obvious that without a suitable standard, or if standardization is not feasible, we cannot exchange domain or user models properly. For domain-independent information about learner traits, the standard is available, such as [6]. But in current AH systems, some modeled relations and features highly depend on the application context or the learning domain. So it is inherently difficult to exchange every aspects of information. Nevertheless, reusing such domain-dependant information still could be made possible via other means if we can properly define relations between different domains, e.g. the method of distributed user modeling [3].

Conclusions

LO and AH address issues on computer-based learning from different aspects respectively. The LO paradigm successfully sets up a standard to exchange learning materials, and lower the cost of developing courseware, while AH develops substantial techniques to enhance learning.

The integration of these two areas would be quite beneficial for disseminating effective learning experiences. Since LO paradigm is very young, the exploration of the integration of AH and LO paradigm is still at the beginning. To bridge the gap, more efforts from both technical and educational aspects are required further.

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