Integrating Learning Objects into an Interactive Simulator for Computer Systems

Abstract:
In the 21st century, learning is an important concern to most people. However, some e-learning applications contain complicated knowledge structure that may hinder reuses and sharing of knowledge. Previously, we developed a simulator to facilitate the understanding of advanced concepts related to computer systems through live animations. To encourage the sharing and reuses of knowledge, we propose to integrate learning objects and relevant technologies into our interactive simulator. By adopting the IEEE learning object metadata (LOM) standard, our simulator may easily exchange or reuse learning objects of relevant concepts with other e-learning systems. In this paper, we review the system design and consider how general or experienced users can benefit from using our LOM-based simulator in different ways. Lastly, we summarize our work and shed light on future directions.

1. Introduction
The IEEE Learning Object Metadata (LOM) standard [3] has become more and more popular among the educational tools which facilitate users and designers in learning and teaching. Learning objects represents the core concepts in a specific field of knowledge which can be independently created, maintained or reused. By properly breaking down the original content into learning objects, course content developers can easily maintain and update the knowledge structure of the underlying subjects, and also make the content easily available to encourage the sharing or reuses of relevant materials, especially to facilitate interactive discussion during and after classes.

In a previous e-learning project funded by Microsoft Research Asia (MSRA), we built the COMPAD simulator to facilitate the understanding of concepts related to computer systems through live animations of events for program execution on relevant components [5]. To promote the advantage of learning objects and related technologies in our educational simulator, we propose to integrate a flexible LOM editor and general-purpose multimedia system to enhance knowledge sharing. The resulting system is mainly divided into four parts. The first part is the simulator that can be used to simulate the computational results of the assembly program on the selected computer architecture for demonstration. The second part is the schema of the LOM and the implementation of this scheme into the simulator so that users can modify the existing learning objects to create his/her learning objects based on the underlying application domain. The third part is the platform for users to create new computer architectures using the learning objects depending on their own needs and preferences. The fourth part is the multi-media system [2] that can be selected by users to show and display the resources and information provided in the detail of the concerned learning objects.

The paper is organized as follows. Section 2 reviews the system architecture design of the resulting simulator and its available services. Section 3 shows the prototype implementation and evaluation. Last of all, the conclusion and future directions will be considered in Section 4.
2. The Architecture Design of the Simulator System
The core functions offered by the COMPAD simulator are provided by the simulation engine [1] and the multi-media controller. The roles of these two components are shown in the system architecture design in Figure 1.

Basically, the simulation engine reads in the three configuration files. It then interprets the source program to generate a sequence of attractive animation in order to highlight the significant events occurring for registers or other key components of the underlying computer system during the program execution. On the other hand, the multi-media control reads information of the metadata for learning objects and the corresponding users’ options to retrieve a specific multi-media file, such as an image or video, stored in the local server. Users can also search such useful learning objects on the web with the aid of the available search engines.

In general, users can simply import the saved assembly program or directly key in the program in the COMPAD simulator. The computed results generated after the simulation will then be displayed in the simulator. However, users can run the simulator in two different ways. For beginners, they can learn more from the information provided in the field of the schema design. There is a platform provided for them to view the related information of the selected learning object so that they can have a clear idea of what the learning object is doing and their inter-relationship more quickly. Alternatively, for more experienced users and designers, they use not only what is provided in the simulator, but also can create something new according to their knowledge about the computer architecture and ultimately integrate them into their designs. Experienced users and designers can also search for information that is stored in the schema according to their preference and show it in different media by
displaying the images or videos that are stored in the definitions of relevant learning objects.

3. Prototype Implementation and Evaluation

In this project, we have successfully built a simulator embedded with a platform to help users to tackle with their problems regarding computer architecture by retrieving relevant information. The role of the LOM in our project is to capture explicit knowledge, context, perspectives, and opinions. The information retrieved can be obtained either from the web or from the database in the form of textual, images or videos, which is monitored by the multi-media controller. Thus, each user will be able to access, discover and find information. Hence, the processes of learning and knowledge creation will be significantly enhanced and accelerated.

Figure 2 and 3 show the LOM editor and the multimedia control developed respectively for our COMPAD simulator.

![Figure 2 – The LOM Editor](image1)

![Figure 3 – The Multimedia Control](image2)

Through the resulting simulator integrated with the LOM editor and multimedia system, users can create the learning objects to suit their needs simply by drag-and-drop, and linking them together as according to their relations. For the schema of learning objects, the LOM editor provides convenient facilities to add, modify or remove any content of the learning objects in the schema so as to create their own definitions. Besides, the multimedia system gives flexible supports to display images or videos as readily embedded in each learning object.

4. Conclusions

We integrate the learning object metadata (LOM) facility into an educational simulator for users to create and work with the specific learning objects in the underlying subject area. The system is very generic so that users may reuse or modify the information inside the existing learning objects so as to create their own learning objects to suit their needs. This will help to shorten the development time of relevant course or simulation materials. All in all, our work has many possible future extensions including the uses of sophisticated visualization techniques to guide the systematic structure of learning objects in a specific field, or the integration of an interactive discussion forum to foster the exchange of ideas among students over a peer-to-peer network.
5. References

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