A Multiple View Authoring Tool for Modeling Training Materials

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Abstract: This paper discusses ontology-aware authoring tool for training systems. This tool uses the ontology as the source of its intelligence. The ontology plays the role of a meta-model which helps authors to construct a model. The major advantages of such an authoring tool are: (1) Providing human-friendly primitives (descriptiveness, readability). (2) Providing multiple-views of the single model of training. (3) Simulating the abstract behavior of the model (conceptual level operationality). (4) Verifying the consistency of models. In this paper we discuss the roles of ontology in authoring tools focusing on (1), (2) and (3). In addition we exemplify the benefits of ontology by giving an overview of the authoring tool SmartTrainer/AT.

Keywords: Ontology in Education, Contents Production with Authoring Systems, Industry Training System

1 Introduction

Deep understanding on "what to be authored" and "how to author it" is quite important to support authoring processes. Training task ontology, as a system of vocabulary/concept of "what to be authored", lays the foundation for human-friendly and representational framework to build the rational models of training systems[1]. Therefore, "ontology-awareness" is one of the most important capabilities required of the authoring tools[2,3].

The another important capabilities are to provide authors with a sophisticated suit of viewpoints to follow along the dynamic movement of the focus of the author's attention and to maintain the consistency among the different views. To realize the capabilities, we have designed a set of interface windows which can sufficiently adapt for variety of author's views and implemented the rational procedure to activate the right window at right situation. The consistency among the contents of different windows is maintained by integrating the contents into the single conceptual model based on ontology specification.

In this paper, we will exemplify the benefits of ontology using SmartTrainer/AT, an authoring tool developed by the authors.

2 An ontology-aware authoring tool

Basically, an ontology is a set of definitions of concepts and relationships and a model is a set of instances of them. Roughly speaking, the role of an ontology is to direct the authors towards the correct model.

Our tool is said to be “ontology-aware” in the sense that it understands the ontology that is the source of its intelligence. The ontology plays the role of a meta-model that helps authors build a model, that is, a training system in a certain domain in our case. This is not a hard-wired model but a set of building blocks with formal semantics, therefore the tool is both flexible and intelligent. This approach makes the tool user-friendly and helpful, since it uses vocabulary from the ontology and the axioms or semantic constraints associated with the ontology can generate timely messages of appropriate types when they are violated. In addition it clarifies the relationship between views of models since it can manage identity and changes of models with the axioms or semantic constraints. In addition, our ontology aware-authoring tool can provide multiple-views of the single model of training. Each of the views is so designed as to be well adapted to the varying context of the authoring

process. Consistency among the views is maintained based on the axioms or semantic constraints specified in the ontology. We could say an ontology-aware authoring tool can share the meta-model/vocabularies with authors and provide authors with comfortable workplace to build teaching materials.

3 SmartTrainer/AT

We have developed a task ontology for Training systems and a domain ontology. Task ontology represents problem solving processes domain-independently [4]. Domain ontology represents the object of the training. It is integrated with the training task ontology that includes the training scenario, learner model and learning item network, and then acquires the appropriate task-dependent meaning in T-Domain ontology. In the substation operator training case, the task is “training” and the domain is “substation in the electric power network”. By incorporating the ontologies into the authoring tool, the support functions shown above have been realized in an effective manner.

SmartTrainer/AT is an ontology-aware authoring tool for substation operator training systems. A domain model author creates the model of an electric power network by instantiating the device concepts and connecting the instances to each other. A task model author creates the teaching materials which are an integrated model of task and domain, called the, T-domain model. The author designs the structure of the intended teaching material, while referring to the domain model. The task ontology provides two types of basic teaching material structure, static and dynamic. Static structure, called a learning item network, specifies various kinds of educational relationships between the learning items, for example, “prerequisite”, “easier-than”, “example-of” and so on. The dynamic structure, called the presentational structure, specifies the control flow of the training, that is, how and when each learning item should be presented to a learner. The presentational structure has two subtypes of structures, courseware and training scenario. Basically, the former describes the systematic method of educational presentation and the latter the opportunistic approach used to support situated-learning. Following the ontology, a model author creates a model through the interfaces, SmartTrainer/AT in this case. If some instantiations or connections are found to be inappropriate according to the ontology, SmartTrainer/AT provides authors with a guidance message to lead them towards an appropriate model.

As we have discussed in introduction, to provide authors with a sophisticated suit of viewpoints to follow along the dynamic movement of the focus of the author's attention and to maintain the consistency among the different views are important functions required of the authoring tools.

We explain authoring processes and interfaces in SmartTrainer/AT in the following sections. Note that all of these environments share a single ontology which allows seamless communication between them.

4 Authoring with SmartTrainer/AT

Our ontology is two layered: conceptual-level ontology and lexical-level ontology. Lexical-level ontology provides a human-friendly vocabulary used by authors to describe their intended model of teaching materials. Conceptual-level ontology specifies the detailed meaning of each concept and the relationship between them. These two levels of ontology have a correspondency with each other. The correspondency enables the translation of one level model into the other level. By incorporating these two levels of ontology into the authoring tools, both user-friendliness of interface and intelligence of active support functions can be realized. In the following sections we will exemplify that these two levels have role in the authoring process.

4.1 Interfaces to create a lexical level model

An author creates a lexical level model through the interfaces that correspond to the concepts he/she notices in a scene of the authoring process. Figure 1 shows the windows used by authors to describe the training scenarios. A training scenario is a presentational structure by which learners practice the target operation according to specified workflow. The training scenario in window (1) consists of a “backbone stream”, which is a sequence of questions, Q1, Q2 and Q3, along the workflow and a “rib stream”, which describes the treatment T1 of a learner’s erroneous answers to the backbone questions. Before the window appears, the author is asked to select one of the target workflows in the domain model and partition it into several pieces. The author then makes a question list for the backbone stream corresponding to the target workflow in window (1).

The author enters the “question intention” and “question” in windows (2) and (3), respectively. The “question intention” in window (2) is a description of the subject of the question, that is, the key domain knowledge required to answer the question. In window (3), the author enters the components of the question/answer, that is, “question”, ”items to be ordered” and “correct answer”.

The diagnosis D1 represents a condition required to execute the rib stream T1. D1 is defined as “The learner makes a mistake because he/she doesn’t know the required knowledge about the topic” as shown in (4). Once ribstream T1 is activated, it does the sequence of teaching activities to the learner in that order. Window (5) shows a goal tree representing the design intention behind T1. The top goal of T1 is expanded into a series of subgoals. This expansion is done based on the teaching strategy, which shows the correct arrangement of teaching activities/subgoals required to achieve the upper goal and acts as a design guideline for the presentational structure. Basically, teaching strategies should be derived from educational principles. Some of them, however, may be heuristic and use subjective knowledge. Thus SmartTrainer/AT uses teaching strategies as a weak constraint for proper modeling to provide the authors with suggestions or recommendations. In addition to this, an author can also design his/her own teaching strategies which may be reused and shared with other authors. In figure 4, the teaching strategy in window (6) is used to expand the top goal in window (6). Thus, the goal of T1 is well described in design phase and provides a good basis for maintenance/reuse of the teaching materials.

Most of the words that appear on the interfaces are from the lexical level task ontology. By selecting appropriate words from the menu or vocabulary browser authors describe the intended model for the training at the lexical level. SmartTrainer/AT provides authors with different views of the single teaching material model through well designed interfaces in order to cope with a variety of authoring contents, for example, (2) and (3) represent abstract view and concrete one of a single question, respectively.

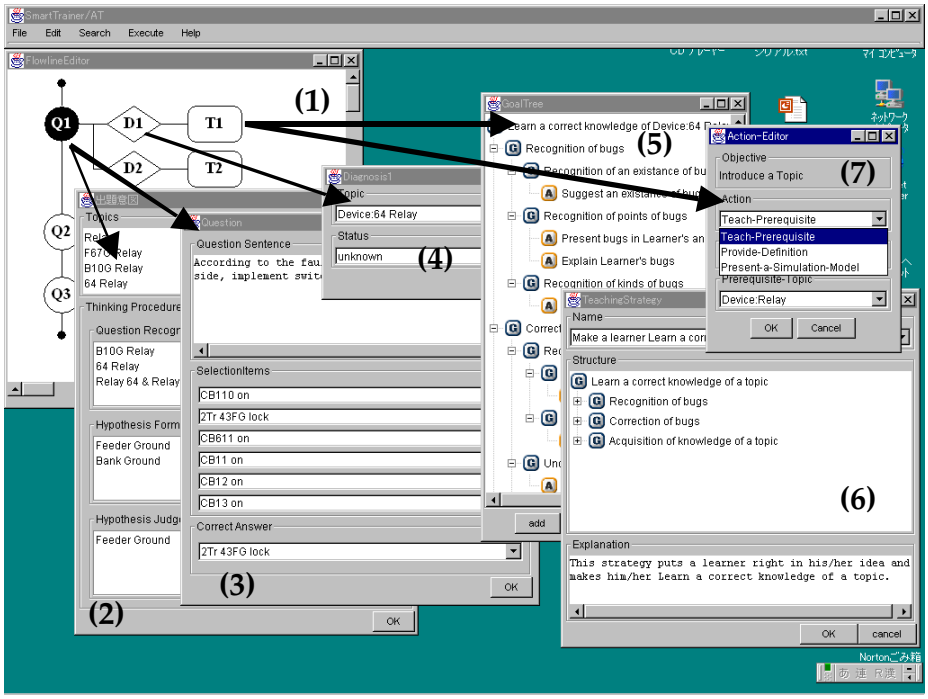

Figure1 Training Scenarios

4.2 Conceptual level execution

By a translation of lexical level into conceptual level based on ontology, SmartTrainer/AT has a conceptual level model as an internal model. Having a detailed conceptual level model enables an ontology-aware tool to provide intelligent support functions for authors. A typical function of this type is the conceptual execution of the created presentation. As the presentation control structure, the learning item network, and a set of cards along with the relationships between them are stored in the conceptual-level model, the ontology-aware tool can simulate any change in the learner’s understanding according to the presentation control structure. This simulation is known as “conceptual level execution.”

Once a conceptual level model has been generated, SmartTrainer/AT can execute it based on axioms about change of the model by processes described in the task ontology. For example the effect of the process “Explain concept C to the learner L”, is defined as “If the learner L is able to achieve the learning process, he/she can understand concept C.”

The author can examine whether or not the training model behaves well for the learner by monitoring the results of the conceptual level execution. Figure 2 shows a snapshot of the interface used to monitor conceptual level execution. Window (2) is used to set parameters in the learner model and target teaching material. A learner model is defined as a simple overlay model on the learning item network.

When the author executes the model, the executor changes the color of the path along which the learner will

learn as shown in window (1), and shows the process of changes in the learner model by changing the color of each node as shown at the bottom of window (2). Using this function the author can verify that teaching material appropriately reflects the intention of the author and identify any insufficient sections that may exist.

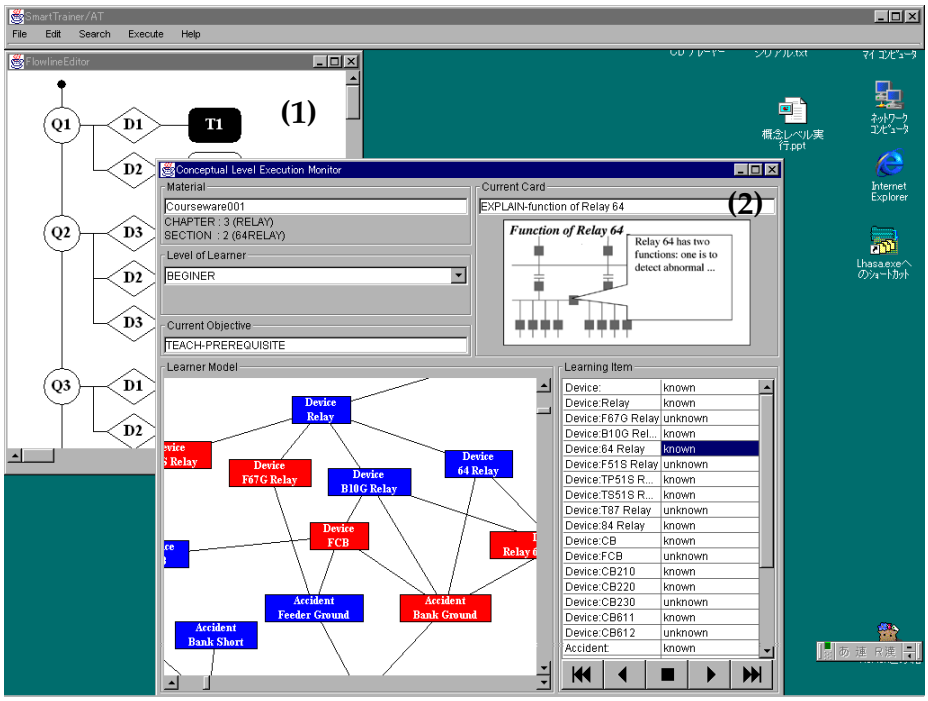

Figure 2 Conceptual level execution

5 Conclusions

In this paper we have discussed the roles of ontology to implement easy-to-use interfaces of SmartTrainer/AT. Two levels of the ontology, lexical and conceptual, make the authoring tool user-friendly and helpful. Lexical level ontology provides authors with an interface suited to his/her ontology literacy by using appropriate vocabulary. Simultaneously the conceptual level ontology specifies the conceptual semantics of the vocabulary and directs the authors towards the correct model using techniques such as “conceptual level execution”. Furthermore, SmartTrainer/AT can provide Multiple-views of teaching materials, because the consistency among the views is maintained based on the axioms or semantic constraints specified in task/domain ontology. So each of the views is so designed as to be well adapted to the varying context of authoring process. These function in SmartTrainer/AT provide authors comfortable workplace to build teaching materials.

We have exemplified the benefits of ontology using SmartTrainer/AT. We have been developing SmartTrainer/AT using JAVA and CLOS. Domain experts comment that SmartTrainer/AT provides a well-designed suite of tools. We intend to make SmartTrainer/AT more user-friendly and intelligent in future work.

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