Design and Development of an Authoring Tool for Pedagogical Relationship Types between Concepts

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Abstract: In this paper the design and development approach of an authoring tool for defining pedagogical relationship types is described. Pedagogical relationship types are used to define adaptation strategies which can be exploited by an adaptation engine to create an adaptive course based on user model information. Taking into account domain models consisting of concepts and relationships between concepts, pedagogical relationships can be used to connect concepts of domain models in a pedagogical meaningful way. Each type of these relationships contains adaptation code which formally specifies the meaning of relationships on a technical and a pedagogical level. To support authors in creating these relationship types a tool is being developed which easily allows the authoring process.

Keywords: adaptation strategies, concept relationship, authoring tool, adaptive engine

Introduction

After more than a decade of research activities in the field of educational adaptive systems (for example [2]) an effort in the context of the EC-funded project GRAPPLE is currently undertaken to develop a generic adaptation approach which can be used in popular Learning Management Systems (LMS) [5]. For this reason the GRAPPLE Adaptive Learning Environment (GALE) is being developed and integrated with the major LMSs (including Moodle and Sakai) using a service-oriented architecture approach. GALE is designed to provide adaptation functionalities to the several LMSs, such as for adaptive guidance through link generation and annotation, or adaptive page content to automatically compensate missing prerequisite knowledge.

In order to fulfil advanced adaptation tasks, GALE is equipped with a domain model and user model infrastructure. For the sake of integration these models are connected with information available in the LMS (content resources and general information on users). While user models are created and updated automatically by GALE, domain models and pedagogical strategies used for adaptation behaviour have to be created by a content author. This paper presents the basis to create pedagogical strategies, which consists defining concept relationship types (CRT) (Section 1) and the implementation of an authoring tool to define a CRT (Section 2).

CRTs have been introduced in the AHA! system [4] after the original approach of using event-condition-action rules based on user model variables has turned out to be an

exhausting task for content authors. A similar approach is used in My Online Teacher (MOT) (http://www.dcs.warwick.ac.uk/~acristea/mot.html). Another approach in this direction has been undertaken in the FP6 research project iClass (http://www.iclass.info/). Skills defined through concepts are related with prerequisite relationships in order to define a meaningful sequence of skills to be acquired [1]. GRAPPLE goes beyond these approaches, since CRTs are can be defined more generic.

1. Pedagogical Relationships between Concepts

A domain model (DM) defines and represents a knowledge domain. Basically, it consists of a set of concepts and relations between the concepts (concept map, see Figure 1). The DM does not represent actual content resources (hyper documents or learning objects), but represents the domain on a conceptual level. Content resources, however, can be related to such concepts. The DM can be created by a teacher/course author familiar with the subject domain, and is visualised as graph where the nodes represent the concepts and the edges represent the relations between concepts.

Basically, three different categories of relationships can be distinguished and are involved in the context of the authoring tools: hierarchical relations, semantic relations, and pedagogical relations. While hierarchical and semantic relations among domain concepts refer to domain knowledge, pedagogical relations define a meaningful sequence of concepts to be acquired by learners. By using concepts from the DM and connecting them with pedagogical relationships the Concept Adaptation Model (CAM) is created which is used by the adaptation engine for the adaptive course (see Figure 1). Special cases are, however, semantic relations or hierarchical relations of the domain model that are exploited for pedagogical purposes. For example, the hierarchical is-a relation between concepts can be used to present them in breadth-first or depth-first manner, as required by the holistic and sequential learning styles, respectively.
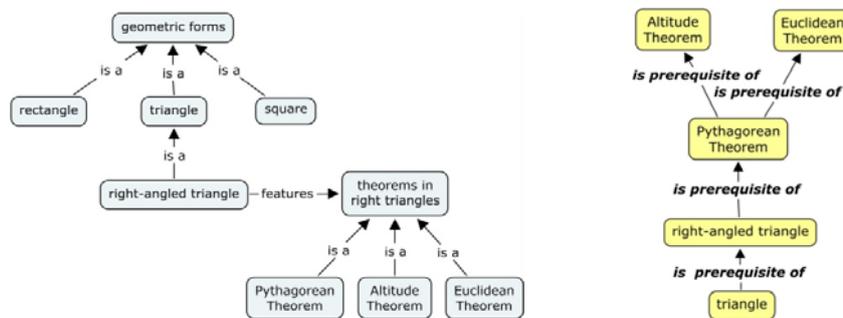
Figure 1: The graph on the left side depicts a domain model and the graph on the right side shows how concepts from the domain model are connected with the pedagogical "prerequisite" relationship type.

The pedagogical relationships described above are instances of concept relationship types. In contrast to the pedagogical relationships which are used between concrete concepts or set of concepts, the concept relationship types (CRT) are the formal specifications of pedagogical relationships. They define the structure how (and how many) concepts can be connected and most importantly they also define the meaning of a pedagogical relationship.

In order to define meaning, a CRT is assigned with a piece of adaptation code which can be interpreted by the adaptation engine. In this way it is specified for each CRT how the adaptation engine should act. The language for this piece of code is the GRAPPLE adaptation language (GAL) which is currently developed. For example, the GAL code for the prerequisite relationship type will be something like "if (user has visited concept A)

then (concept B is suitable)". As seen in this example, the user model variables can be accessed using the adaptation language. Information of a user, such as visiting state of a concept or knowledge level of a concept can be used to formally define the adaptation behaviour.

2. Implementation of an Authoring Tool for Concept Relationship Types

The CRT authoring tool consists of a Web-based tool which provides the possibility to create and define CRTs and a Web Service where the created CRTs can be stored and retrieved by other tools. Authors can input the information described above in a graphical way and save them to the Web Service. For the reason of interoperability the CRT data is expressed in an XML-based format and the certain CRTs are saved as XML files on the server side into a database behind the Web Service. The graphical tool is implemented in Adobe Flex 3 technology (http://www.adobe.com/de/products/flex/) and the Web Service is realised with Apache Axis2 framework (http://ws.apache.org/axis2/).

The Web-based tool offers a graphical user interface where a CRT can be defined. The information needed to specify a CRT includes: (1) general information of CRTs, such as name and description; (2) information how an instance of a CRT should be visually represented in the CAM; (3) the GAL code which formally defines the adaptation behaviour; (4) structural information how many concepts are connected with each other; (5) constraints, such as the information whether sequences of CRT instances may form a loop; and (7)some technical information such as creation time or author.

The most challenging part of the tool development is to provide as much as possible support to the author who wants to create and modify adaptation code. Programming adaptation code directly in GRAPPLE adaptation language excludes most content authors who do not have programming skills available from creating their own CRTs. Therefore, this authoring tool shall provide graphical techniques, which allows an inexperienced author to create new CRTs easily. Further development will focus on providing visual support for authoring the adaptation behaviour which is expressed in programming code. This should enable beginner authors to create new CRTs or to modify existing ones.

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