Domain Model (DM) Enhancing Adaptation Process in Adapti e-Learning Hypermedia Systems (AeLHS): Survey

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Abstract

Due to the increasing complexity of web site navigation, but also as a response to the "one size fits all" approach, adaptation mechanisms have emerged and have started to be used by a large number of on-line eLearning systems. As learning content may be delivered through various types of networks that differ in characteristics and vary with the time, the quality of the transmitted information is affected. DM for adaptive hypermedia proposes to overcome this barrier by taking into consideration in the personalization process not only the classic student profile but also the performance of the network connection used by the learner, when rich media content is delivered. The goal is to provide surveyed to personalized media rich content suitable for the learner DM enhancing adaptation process in adaptive e-learning Hypermedia Systems (AeLHS). Based on the literature review, we have identified a number of theoretical and technical issues related to the AEHS architecture in relation to the DM model to achieve an effective learning outcomes. The findings will be used for designing a DM model for AeLHS.

الملخص

نظرًا للتعقيد المتزايد للتنقل وتصفح مواقع الويب، وأيضًا كاستجابة لنهج "مقاس واحد يناسب الجميع"، ظهرت آليات التكيف وبدأ استخدامها من قبل عدد كبير من أنظمة التعليم الإلكتروني عبر الإنترنت. نظرًا لأنه قد يتم ايصال محتوى التعلم من خلال أنواع مختلفة من الشبكات التي تختلف في الخصائص وتختلف في الزمن، عليه فإن جودة المعلومات المرسلة تتأثر. يقترح نموذج المجال للوسائط التشعبية التكيفية للتغلب على هذا الحاجز من خلال مراعاة عملية التخصيص ليس فقط ملف تعريف الطالب الكلاسيكي ولكن أيضًا أداء اتصال الشبكة الذي يستخدمه المتعلم، عند تسلم محتوى الوسائط الغنية. والهدف من ذلك هو توفير محتوى غني بالوسائط الشخصية تم مسحه ومناسب للمتعلم (نموذج المجال) لتعزيز عملية التكيف في أنظمة الوسائط الفائقة للتعلم الإلكتروني التكيفية. بناءً على مراجعة الأدبيات، حددنا عددًا من القضايا النظرية والتقنية المتعلقة بأسلوب بناء أنظمة الوسائط الفائقة التعليمية التكيفية--فيما يتعلق بنموذج المجال لتحقيق نتائج تعليمية فعالة. سيتم استخدام النتائج لتصميم نموذج المجال لأنظمة الوسائط الفائقة للتعلم الإلكتروني التكيفي.

Keywords: Adaptive eLearning Hypermedia Systems, Domain Model, Modeling Techniques.

1. Introduction

Adaptive Educational Hypermedia Systems are plagued by the same problems that all rich content and link structured hypermedia systems exhibit: the student suffers from the "lost in the hyperspace" and when s/he finally arrives to the targeted information, s/he realizes that the information is either too complex and further explanations are required, or too many details are presented and it is difficult to follow it. This happens when the provided information does not suit student goal, learning styles and knowledge. Adaptive Educational Hypermedia (AEH) comes as a solution for these problems by providing adaptive navigation support (link adaptation) and adaptive presentation support (content adaptation) based on a student profile [1].

Based on hypermedia systems, the Adaptive Educational Hypermedia Systems (AEHS) appeared in the 1990s to tailor personalized learning contents. An AEHS consists of three main components; the Domain Model (DM), the User Model (UM) and the Adaptation Model (AM). The DM defines the subject area and the learning material that has to be used as a learning resource. The UM is a collection of a user characteristics that the DM content has to be adapted to satisfy them. The AM describes how the content has to be adapted to satisfy user characteristics defined by the user model, two major components of the hypermedia can be subject to adaptation, the presentation (content) and the navigation through the hyperspace (links) [2].

The DM is used to model the educational content in order to delivered rich multimedia content through AEHS.

The rest of this paper is organized into five sections: Section 2 provides theoretical framework and background on the definition of domain model for AEHS which has been implemented by the developed AEHSs. Section 3 surveys the technologies used and related work to developed domain model. Section 4 is devoted to the conclusion and future work.

1. Theoretical Framework

The educational benefits afforded to learners by Technology Enhanced Learning Environments (TELE) which adapt and personalize the learning experience. More specifically we focus on Adaptive Educational Hypermedia Systems (AEHS) that incorporate domain model. Adaptive approaches to learning offer alternatives to the traditional "One-size-fits-all" approach and have driven the development of dynamic educational environments. The use of such environments can deliver educational benefits as educational offerings are personalized based upon various characteristics of individual learners.

2.1. Adaptive Education Hypermedia System (AEHS)

AEHS which has evolved through time provides methods to personalize system through tailoring the content presentation, navigation, and services according to individual characteristics such as user's background, previous knowledge, interests and other preferences. The user's characteristics are stored in one of the main components of AEHS, the user model (UM). As an example, AEHS personalize the educational system and tailor the content of the course according to user's prior knowledge to match the level of user's knowledge. Then AEHS evolved to fit the current status of the user through having a more dynamic user modeling that suggest the most suitable navigational links matching user's current state. AEHS is considered the most interesting and popular application area of adaptive system, which personalize the educational systems, to learners who have differences in learning goals, knowledge, preferences, and interests which need special interaction and treatments. Most AEHS systems are considered technology-driven since they focused on transferring the knowledge as a main aspect of learning process rather than pedagogical-driven which allow the system to address other aspects such as the preferred way of learning from psychological perspectives, which have the ability to increase the performance of learning in either cognitive or affective domain. Furthermore, current research which integrate AEHS with educational and psychological theories has shown the potential to overcome the pedagogical challenges in AEHS. A number of AEHS such as the ones shown in Table (1) were developed based on student's characteristics. Most of them focused on prior-knowledge. A number of studies verified the effectiveness of modeling the adaptive system based on prior-knowledge. This means that the user learning performance is increased by enhancing the academic achievement or learning outcome. Moreover, the user will get more satisfaction.

Table 1: Adaptive Systems based on User Characteristics

Adaptive eLearning System	**Domain Model Based on**	
ELM-ART [8]	Knowledge	preferences
ISIS-Tutor [9-10]	√	
ITEM/PG [11]	√	

HyperTutor	√	
SHIVA [12]	√	
Hyperadapter [13]	√	√
AHA! [14]	√	√
Netcoach [15]	√	√
Interbook [16]	√	
CHEOPS [17]	√	
TANGOW [18]		√
WHURLE-HM	√	

2.2 Domain Model (DM)

This section gives a precise definition of the domain model (DM), the (DM) contains fragments of educational content (e.g. multimedia clips) between which logical relationships exist. Fragments may be grouped based on the relationship between them in order to form concepts. The concepts are grouped again in order to form a more complex concept, or even educational units. In order to provide the separation between the DM and AM, a concept must be uniquely identified. Therefore, every concept within DM has an attribute, concept Id, which will uniquely identify the concept. In this way, the adaptation rules are created for a class of concepts, instead of having rules for every individual concept, which would be unrealistically for large courses or courses on which the concepts change quickly (e.g. a course for the fields where the information becomes quickly outdated). Every fragment has associated specific attributes (metadata). In order to allow multimedia manipulation, the domain model is enhanced with specific attributes based on the resource type. Text, image and video fragment types are considered. The following metadata is added:

- **Text** files metadata: size (kilobytes), length (number of words), format (e.g. plain text).
- **Image** files metadata: size (kilobytes), format (e.g. jpg), resolution (pixels).
- **Video** files metadata: bitrate (megabits per second), framerate (frames per second), resolution (pixels), colors (number of colors represented in bits required for encoding), encoding (e.g. MPEG4).

  DM allows multiple versions of the same content to be associated with the same fragment. Different versions of video with different qualities are associated to each fragment. Based on the attached metadata (which describes their performance characteristics) and taking into account the network performance, the version which best suit to the student is delivered [3]. The domain model is stored in one of the main components of AEHS; figure (1) below illustrated the AEHS components.

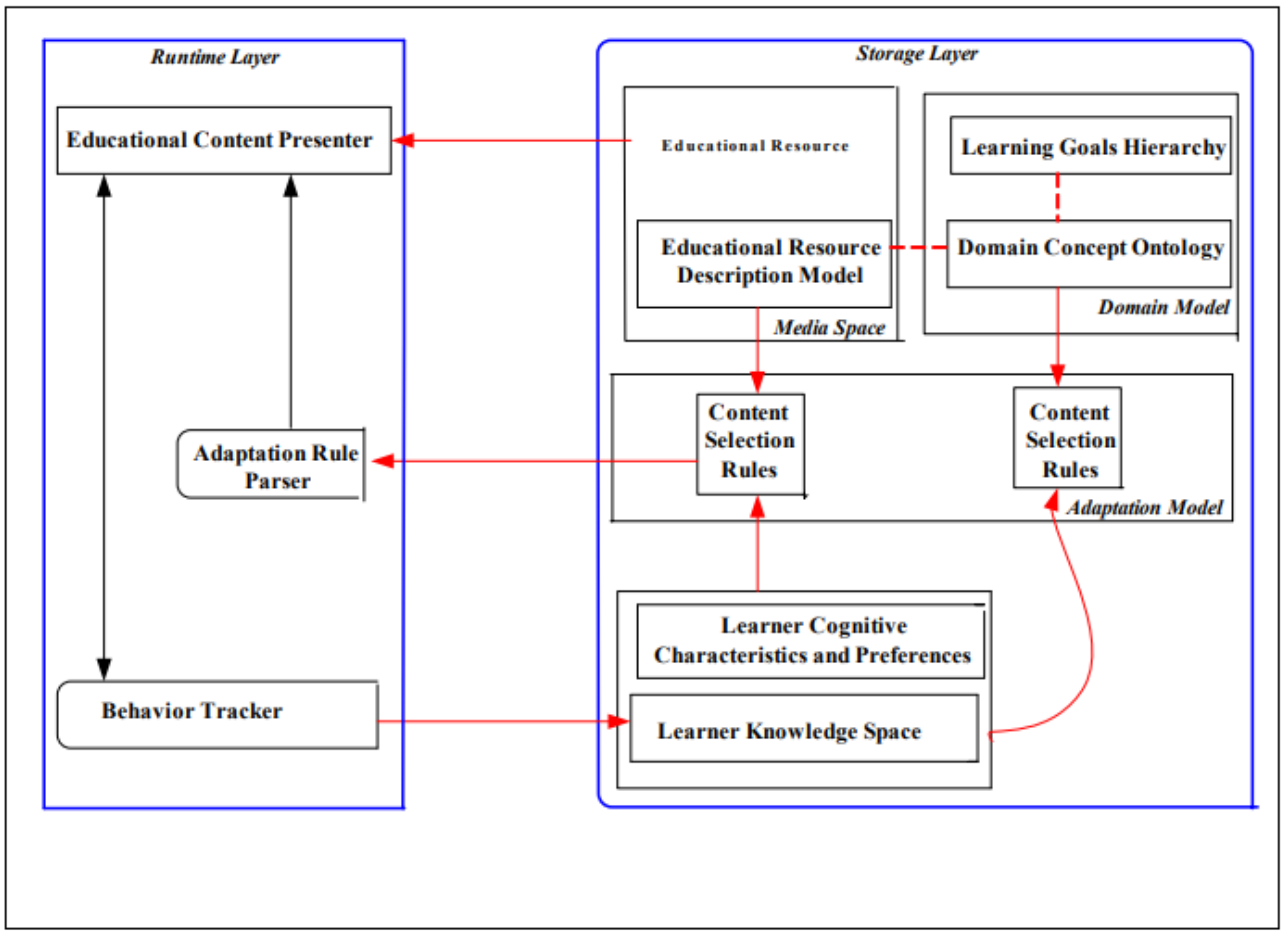

Figure (1): Generalized Architecture of Adaptive Educational Hypermedia System [5]

Different AEHS have been developed and they consider different aspects related to the student such as: knowledge, goal, learning style, student device, prerequisite and experience, etc. A number of research projects have also focused on innovative techniques for modeling the learning resources (DM). While most of AEHS are based on the student knowledge, interests or learning styles there are very few who have considered student connectivity conditions when it comes to transmitting the education content. It had been shown that the combination of the network quality of Services with the personalized delivery of educational content containing text and images, improved the learning outcome [3, 4]. Since video files are progressively used for providing educational content, their quality as perceived by the student when delivered over a given connectivity should be analyzed and considered in the content selection process. These files, having a large size, are difficult to be transmitted over the network and delay and loss of information are unavoidable. The delay affects the student that has to have patience until the video is downloaded. Loss affects the integrity of the delivered information. Considering all these aspects we believe that adaptive e-learning systems should consider student connectivity aspects in the personalization process as well as the suitability of a given media clip to the current network delivery conditions. Metadata on the characteristics of the multimedia content such as bit rate, resolution, file format should be added to the domain model and later on to be used by the adaptation model. This paper focuses on presenting how this metadata can be authored in the Domain Model and used by the Adaptation Model in the content selection process.

3. Technologies Used in Developing domain model for AeLHS

The goal of developing AeLHS is to achieve an effective and affective learning performance, as well as to get positive impacts on the student through gaining skills and learning experiences. The domain modeling that involves a specification of concepts and structure from crucial aspects of the system. The domain model is used to define which information will be processed in the application. The content can be specified in terms of such structures as: **conceptual maps**, **semantic networks**, **conceptual graphs** and **ontology.** The basic premise of the adaptive interfaces in AEHS is that the feature of the information can be adapted by the perception of the students' needs in agreement with the context of the usage of the system. In many cases, the adaptation is reached by the maintenance of an explicit model of student used to guide the adaptation. This can be made by the representation of the intentions or of the students' attributes (knowledge, level of abilities, etc.). In other cases, the model is implicit; being considered the characteristics of interaction of the system. The intention of the adaptive interfaces is exactly to improve the interaction man-machine through interventions that aid the users to reach their objectives [6]. Table 2: shows the systems that implemented domain model for AEHS.

Proposed Domain Models Systems	**Authors**	**Years**	**Techniques Used by the Model**
PAMAH (Performance-Aware Multimedia-based Adaptive Hypermedia)[4]	Andreea Molnar, Cristina Hava Muntean	2009	Performance-oriented metadata
AHA! -an Open Source AESH[7]	P., De Bra, D., Smits, N., Stash,	2006	Performance-oriented metadata
Formal Model (AEHS) in Biomedical Engineering[6]	Maria A. Fernandes Almeida and Fernando M. de Azevedo	2008	Categories Theory (CT)
Multi traits dynamic user model for AEHS[3]	Nafisa, A., Hassan, Noureldien, A., Noureldien	20018	Hierarchical structures

4. Conclusions and Future Works

In this paper we have describe the domain model techniques issues to enhanced adaptation process in designing reliable approach for AeLHS. We classified these issues into theoretical framework which focus on the Adaptive Education Hypermedia System (AEHS) component and DM, essentials of affective education as a main, which currently focused on transferring the knowledge to enhance learning. In order to achieve the domain model which describes how the information is structured and linked together perspectives to enhance adaptation in AeLHS. Based on these review, questions to guide future research is: How to use the group of modelling techniques to develop DM based on the proposed AEHSs as a way to solve what so called “adaptation in AeLHS”? The challenge for the authors is to be aware about the variety of available modelling techniques and pick the right ones for the work. Finally, we hope that the anatomy of AeLHS design and a survey of existing modelling techniques provided in this paper will be helpful for the researchers in the field of AeLHS of practical educational hypermedia systems.

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