QoE-MOT – A Learner Quality of Experience-Oriented Authoring Tool

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Abstract. This paper introduces Quality of Experience My Online Teacher (QoE-MOT), a user quality of experience oriented version of the generic authoring tool MOT. QoE-MOT is an authoring tool which enables the creation of performance-aware adaptive courses, by adapting the educational content to the learner network conditions. MOT was developed based on LAOS, a complex five layer authoring model. In similar fashion, QoE-MOT was constructed following the QoE-LAOS, a learner quality of experience oriented authoring model. This paper illustrates how an adaptive educational course has been enhanced with performance oriented metadata and how this metadata and QoE parameters are used during the adaptation process.

Keywords: Authoring tool, Adaptive e-learning, LAOS, QoE, MOT, LAG

1 Introduction

Adaptive Hypermedia (AH) has been suggested as a solution for decreasing the complexity of web site navigation and for offering information tailored to the user needs. Different Adaptive Hypermedia Systems (AHS) have been proposed to offer personalised content that takes into account the user characteristics such as knowledge about a certain subject (especially in the educational area) [1], goal [2], prerequisites and experience [3], emotional and physiological state [4] etc. Recently, due to the heterogeneity of existing networks, the user's perception has been shown to differ for the same online material. The influence of the network parameters has been the reason behind adding a new layer to the AHS, a Quality of Experience (QoE) layer [5]. This layer addresses the differences in performance between users.

The main drawback of the AHS is that the process of creating the adaptive content is time consuming, and it is not always trivial for a non-expert user [6]. In order to ease the authoring process, making the personalisation more an automatic process, different authoring tools have been proposed, such as MOT [7], ACCT [8], MEAT [9], T-MAESTRO [10], etc. However, none of these authoring tools offers adaptation support for modeling differences in the access capabilities of different users.

In this context, this paper introduces Quality of Experience My Online Teacher (QoE -MOT), a user quality of experience-oriented version of the generic authoring

tool MOT. QoE-MOT is an authoring tool which enables the creation of performance-aware adaptive courses. In similar fashion, MOT was developed based on LAOS [12], QoE-MOT was constructed following the QoE-LAOS, a learner quality of experience oriented authoring model which was presented in [11].

The paper is organised as follows. Section 2 briefly presents the LAOS and QoE-LAOS authoring models. Section 3 describes QoE-MOT and section 4 presents the conclusions and future work directions.

2 Performance Oriented Authoring Model: QoE-LAOS

QoE-LAOS [11] extends LAOS (Layered WWW AHS Authoring Model and their corresponding Algebraic Operators) [12], a complex layer-based authoring model for Adaptive Hypermedia Systems (AHS). QoE-LAOS allows content adaptation by taking into account the differences which may exist between users in terms of devices and network characteristics.

QoE-LAOS inherits from the LAOS authoring system the following five layers:

- *Domain Model (DM)* represents the information which needs to be delivered. It is organized in concepts and their attributes. Concepts are atomic or composite concepts. Attributes describe the characteristics of the concepts.
- *Goal and Constraints Model (GM)* defines goals and constraints.
- *User Model (UM)* stores relevant information about the user.
- *Presentation Model (PM)* allows defining different ways of presenting the material contained in DM.
- *Adaptation Model (AM)* contains adaptation rules. The rules make references to the information contained in other layers: DM, GM, UM and PM.

The quality of experience was integrated in the authoring model, by extending three layers of the LAOS with new QoE-oriented sub-layers (Fig. 1):

- DM with *QoE Content Features sublayer* – metadata describing performance characteristics is added to every concept in the DM with a physical representation (text, image, web page, multimedia). The metadata may be added manually by the author, or automatically, by the system, when a concept with a physical representation is introduced.
- PM with *QoE Characteristics sublayer* – defines in abstract manner classes describing performance characteristics. Based on the current learner network characteristics it gives suggestions about what content should be displayed to the learner. For example, the *QoE Characteristics sublayer* may suggest that a just a video under a certain bit rate may be delivered properly.
- AM with QoE Rules sublayer – defines adaptation rules based on QoE characteristics. These rules make reference to the metadata added in *QoE Content Features sublayer* as well as to the suggestions given by *QoE Characteristics sublayer*. Different strategies may be introduced at this level, given the author the possibility to choose between them. In the same time, the author does not necessarry need to write the strategies by her/himself, the time and the difficulty of the authoring process remaining the same.

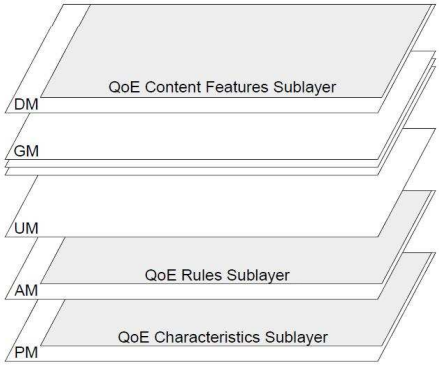

Fig. 1. QoE-LAOS – additional three QoE sub-layers

3 Quality of Experience MOT: QoE-MOT

Technological development, especially in the field of computer networks, has allowed users to access online content by using multiple access networks and using different mobile devices. Accessing online content from networks that are heterogeneous in nature, (they have different characteristics), influences the way in which content is received by the user, both from a quality point of view as well as by considering the delays perceived during the reception of the content. It has been shown that the learner QoE with the e-learning system may be increased if the content adaptation is also done based on the user network characteristics [5].

Table 1. Performance Features based on Content Type

Content Type	Attributes
text	*size* – measured in kilobytes
	length – represents the number of words
	format – it is a code; 0 represents plain text, whereas 1 represents HTML
image	*size* – measured in kilobytes
	format – is a code, e.g. 0 for png file, etc
	resolution –expressed in pixels
webpage	*size* – measured in kilobytes
	tsize – the total size, measured by including also the embedded objects
	objects – number of objects embedded in the page
multimedia	*bit rate* – measured in megabits per second
	frame rate –measured in frames per second
	resolution – measured in pixels
	Encoding – encoding scheme, e.g. MPEG4

Authoring the network characteristics may be difficult and time consuming especially for a person without an engineering background. This process may become more efficient if an authoring tool would be provided. This paper exemplifies how MOT may be extended and used to author performance related information. MOT [7] is a generic authoring tool which follows the LAOS authoring model.

QoE-MOT, an extension of MOT, was built as an authoring tool which helps non expert users, to create adaptive content, by taking into account not just the user profile, but also network performance issues. QoE-MOT follows the QoE-LAOS [11] authoring model. For each concept from the Domain Model (DM) performance related features have been associated such as size, format, etc (see Table 1). For every physical presented concept, multiple versions that differ in quality are considered. For example, the *Superlative Forms* concept has four atomic concepts associated: multimedia, webpage, image and text (Figs. 2 and 3). Every atomic concept has general attributes such as title, explanation, etc. generated by MOT, plus performance oriented attributes (e.g. size, length, resolution, etc.) introduced using QoE-MOT.

The AM from LAOS is instantiated by LAG [13] adaptation language. We used this language in order to exemplify adaptation rules, which may be created using the performance oriented metadata.

The code presented next checks whether the attribute accessed is of type *bitrate*. Then, it checks if the bit rate is less than the recommended bit rate: *max.bitrate.* If the condition is true, then the *UM.GM.suitable* variable is set to true, *UM.GM.suitable* being a user defined variable. Then the rule checks if the concept accessed is suitable to be shown (*UM.GM.suitable* is true). If it is suitable the concept, representing a multimedia, is displayed.

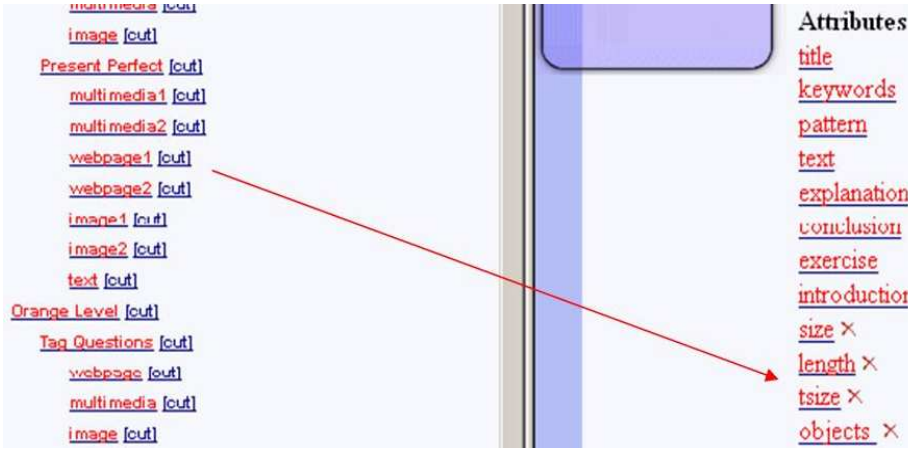

Fig. 2. Metadata associated with the "webpage" atomic concept

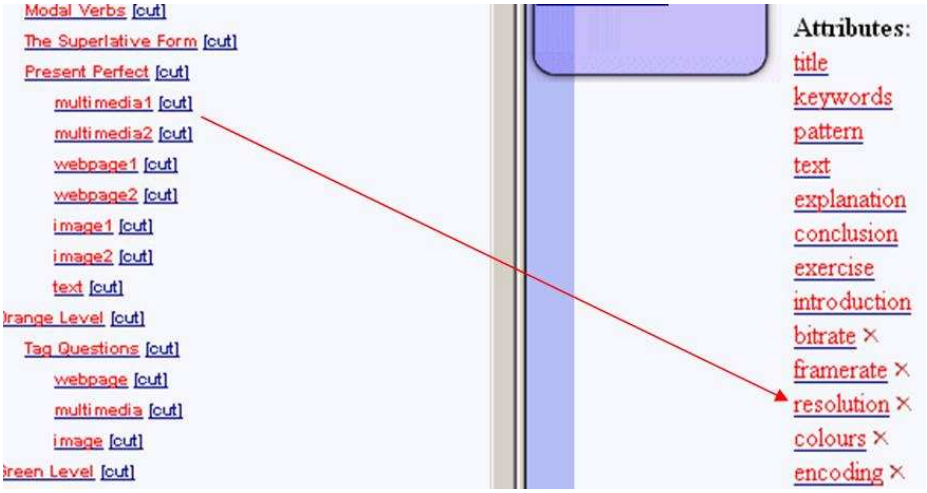

Fig. 3. Metadata associated with the "multimedia" atomic concept

```
//It checks if the multimedia bit rate is lower than
//the required value
if enough (DM.Concept.access
           DM.Concept.type == bitrate
           ,2)
then (if DM.Concept.bitrate <= maxbitrate
      then UM.GM.suitable = true
      else UM.GM.suitable = false)

//If the concept is suitable to be displayed show it
if enough (DM.Concept.access
           UM.GM.suitable == true
           ,2)
  then PM.GM.Concept.show = true
```

4 Conclusions and Future Work

The paper presents QoE-MOT, an authoring tool which aims at helping the authors of adaptive systems to create adaptive content by also taking into account delivery performance issues in order to increase learner quality of experience. A brief description of the QoE-MOT in terms of its new QoE components was presented and an illustration on how a QoE-aware adaptive rule can be created was provided. Due to the space limitations, more details on creating different QoE aware adaptation rules as well as designing QoE adaptation strategies wil be provided in a new paper.

We are also working on authoring a QoE aware adaptive course, using QoE-MOT. Tests will be performed in order to evaluate the benefits of using QoE-MOT. Additional work is required to obtain an automatic procedure, for determination of the performance parameters such that the development of performance aware adaptive content is eased, especially for non-expert users.

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