

The Multi-model, Metadata-driven Approach to Content and Layout Adaptation

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Abstract. Delivering content adapted to not only an end user's needs and preferences, but also to their context and environment presents a number of research challenges. The multi-modal nature of content delivery coupled with the diversity of interests and requirements of a user means that a large number of techniques and mechanisms may need to be employed to tailor the content delivered. However, it is important that the research for related fields should be leveraged to maximum effect. This paper introduces the high level techniques employed in Adaptive Hypermedia and in particular focuses on the Multi-model, Metadata-driven approach to Content Adaptation [5] developed in Trinity College, Dublin.

1 Introduction

Adaptive Hypermedia [2] [7] has been an area of research since 1996 and has primarily focused on adapting hypermedia content towards the needs of a user, or in the case of personalized eLearning, towards a learner characteristics. Such characteristics include the goals and objectives of the user, their prior experience of the subject matter, their preferences for how the material is delivered and displayed and cognitive parameters, such as learning style. More recently additional influences on how content may be delivered adaptively have been considered. These include adapting to the device the user is receiving the content through, but may be extended to additional environmental considerations. Such considerations may include network bandwidth, connection reliability, ambient noise levels and proximity to other people. Such information is often branded as Context Information.

Ultimately, this information is used as the sources upon which the adaptation of content and delivery are based. Adaptive Hypermedia broadly considers two areas of adaptation – Adaptive Navigation and Adaptive Presentation. Adaptive navigation describes how the content may be structured and describes how *views* across the content space may be provided. Adaptive presentation is directly concerned with the rendering of pieces of content. Associated with both areas of adaptivity are a number of techniques, such as link hiding, link sorting and link annotation in the case of adaptive navigation and conditional fragments, stretch text and content inclusion/removal in the case of adaptive presentation.

However, the application of these techniques must be appropriate to the needs of the user and their current context if the adaptation is to be appropriate and effective. This paper briefly introduces the multi-model, metadata driven approach for adapting content to these different sources of information and describes how different sets of information sources can influence different forms of adaptivity.

2 Content and Layout Adaptation using the Multi-model, Metadata-driven Approach

The multi-model, metadata driven approach to adaptivity developed at Trinity College, Dublin describes the separation of the concerns that influence adaptation into discrete elements. This approach is different to that taken by many other Adaptive Hypermedia approaches [2] [3] [7], where the content and the adaptive logic that determines how it may be adaptively composed are intertwined. In the multi-model approach the different elements of adaptivity, such as the user model, adaptation model (or narrative as it is called in this approach) and content model are kept discrete and separate. Other models, such as environmental and device models may also be considered. This may be done separately or the information may be gathered by a Context Information Service. Moreover, each model used is described with appropriate metadata that describes how it may be used adaptively. This adaptive description may be influenced by any element of the metadata or may use specific or customized elements [4].

The narrative and its association with the other models is the key to the multi-model, metadata-driven approach. The first important aspect of the narrative is that it maintains a conceptual abstraction between itself and the actual content. This enables the narrative to be described at a conceptual level, without being con-

cerned with the actual content that will realize those concepts [6]. This abstraction facilitates a number of possible adaptive solutions to delivering content. The first is that there may exist a number of *candidate* pieces of content that may be used to fulfill the concept. During the adaptation process the concept described in the narrative must be realized by selecting an appropriate candidate. The selection process is facilitated by the metadata describing the different candidates. This approach is very effective, but requires multiple candidates to exist for a particular concept. The second approach is to choose an appropriate candidate as described above. In this case, however, there is a limited set of candidates, each of which has no particular layout or styling applied to them. They differ in terms of difficulty or target audience, for example. These considerations are very much user centric. The layout and rendering of the material may be adaptively influenced also. These considerations are both user based and device/environment based. Adaptive layout may take the form of adaptively writing a transform at runtime or the adaptive selection of styling components and often involves a combination of technologies such as XSLT and Cascade Stylesheets [1]. The second important feature of the narrative is that it may be adaptive at the conceptual level, through the reconciliation of metadata. This facilitates the inclusion/exclusion of concepts according to the needs or objectives of the user (as described in their metadata model). It also facilitates the adaptive sequencing of those concepts in order to best achieve the user's goals.

Briefly described in this section is the multi-model, metadata-driven approach. This approach facilitates adaptation at a number of levels – at the conceptual level and at the level of the actual content itself. APeLS, the adaptive personalized eLearning service [5], is an implementation of this approach for the eLearning domain.

3 Conclusion

This paper has briefly described the research area of Adaptive Hypermedia and some of the techniques employed to adapt to a user. Highlighted also is the multi-model, metadata-driven approach to content and layout adaptivity and the mechanisms employed in this approach to maintain separation of concerns. Through this separation adaptivity may be achieved at multiple levels and towards different sources of information, including both user and context information.

Of particular interest to this workshop is the central importance of metadata in this approach. Metadata is used to facilitate the appropriate selection of candidate content (as well as being used to describe and select all other models). It is also used by the narrative to reconcile the different models at runtime to produce the high level adaptivity.

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