Engineering Information Systems towards facilitating Scrutable and Configurable Adaptation

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Abstract. End users of Adaptive Hypermedia Systems (AHS) receive an experience that has been tailored towards their specific needs. Several AHS have produced favourable results showing benefits to the user experience [2]. However, the nature of AHS is that they tend to operate across a focused and fixed domain with a single body of content that is known a priori. This approach limits the user's freedom to choose other information sources and restricts the potential impact an adaptive systems may have. To provide more flexibility several service orientated approaches extending traditional AHS architectures have been introduced. This Ph.D. work proposes the re-engineering of information systems in order to support the portability of adaptive services, thus enabling them to personalize any information system on behalf of the user. This approach espouses user empowerment through this mobility and through a highly scrutable and configurable approach to such service-oriented adaptation.

Keywords: Personalization, Adaptation systems and techniques, intelligent agents for personalization and adaptivity.

1 Introduction

Adaptive Hypermedia Systems (AHS) typically concentrate on adapting content and structure within a specific domain to a user's needs and preferences. They have achieved quite high degrees of success [2]. However, these attempts to overcome the 'one size fits all' issue are isolated, contextualized and highly domain specific. Most adaptive systems rely on a fixed and well known environment, consisting of a well described domain, adaptive logic and various other information models [10]. Although this approach can be effective within the defined domain, it mostly results in an inflexible and dependant architecture. Once designed, it is difficult and costly to alter. From a users perspective these approaches potentially minimize the 'lost in hyperspace' experience, but can lead to a loss of navigational freedom within the content and in the choice of content repositories. A user should have the choice of accessing different information sources without any assistance or, if using an adaptive system, being able to use it in a flexible and scrutable manner.

Recent approaches, such as APeLS [5] and KnowledgeTree [3] are heading in this direction by attempting to abstract the adaptation process from the adapted and personalized information. These service-oriented approaches have initially concentrated on the adaptation logic, but have not yet offered guidance on how the information system[1] they are adapting may be modified to best accept their recommendations.
This work concentrates on re-engineering information systems in order to best accept recommendations from adaptive services. For the adaptive service this approach leads to more flexibility in the choice of the information system and for the user it enables possibilities for a higher level of control and scrutiny in what has been adapted on his behalf.

Therefore the research introduced in this paper addresses the following challenges:

1. To enable more flexible and independent adaptive services.
2. To develop a reference model for designing information systems towards facilitating such flexible and independent adaptive services.
3. To design a holistic adaptive approach emphasising the needs of the user by providing appropriate possibilities for scrutiny in all adaptive processes.

This paper, which reflects the early stages of Ph.D. research, will give a brief overview of the State of the Art in the described subject area, followed by a simple Use Case and conclusion considering the proposed research challenges.

2 State of the Art

In the following, different traditional and service orientated approaches in the research area of AHS will be discussed.
The Adaptive Personalized eLearning Service (APeLS) [4] is service based, with a generic adaptive engine implementing a multi model approach. This approach provides the possibility of creating independent narratives representing the adaptive logic in a flexible way [5]. APeLS service orientated design, allows flexibility not only within the model approach, but also towards different information systems and platforms.
A different approach is followed by ELM-ART [12]. The two main adaptive features are *visual adaptive annotation of links* and *individual curriculum sequencing*. For adaptive annotation of links a multi-layered overlay model is used leading to a visual annotation of the links according to the learning state of the corresponding unit. The individual curriculum sequencing is based on an optimal path calculation using the current learning goal and all prerequisites necessary to reach that goal. In addition the learner can alter the adaptation logic indirectly by editing the learner model.
AHA! [6], as another example, provides *adaptive link hiding or link annotation* and *conditional inclusion of fragments* with a concept based overlay user model. Changes

[1] In this context an information system is seen as a semantically enriched content repository providing service orientated interfaces and structured web-based access.

in the user model are defined by adaptation rules which can be created manually with a concept editor. Even though ELM-ART and AHA! provide powerful adaptive features and additional tools for the simple creation of adaptive courses they miss the flexibility of a web service driven architecture.

Most adaptive systems provide sound adaptive features, but it is still a complex undertaking to add a new domain area, user group or adaptive logic. In order to overcome this disadvantage some AHS are based on an underlying reference model.

The most fundamental reference model in hypermedia is the Dexter reference model [8] which inspired several extensions. In this context especially those with the focus on semantic interoperability of different components and links are of interest. For example, the AHAM reference model consists of user model integration, session independency and the enabling of plugging different adaptive techniques into the reference model [7]. Many of the AHA! features are inspired by the AHAM reference model [6]. A different, but also Dexter model based approach is followed by Albert and Hockemeyer [1]. They introduce an extension of the Dexter model connecting hypertext structures and knowledge space theory by using the concept of prerequisite links in dynamic hypertext to create individual learning paths. Wang on the other hand extends the Dexter model to support semantic relationships between nodes [11]. These concepts lead to the promising conclusion that designing adaptive approaches based on accepted reference models can lead the way into more flexible adaptive approaches.

These models, however, focus exclusively on the abstracted modelling of the system and do not make reference to the quality of the end-user experience. In order to provide a holistic adaptive approach it is seen as essential that the adaptive service provides the user with the possibility of scrutiny. This supports the user in examining what has been modified on their behalf and why it has been modified [9]. The goal is to provide transparent and scrutable access to both the user model and all adaptive processes. This in effect should potentially lead to a more involved experience of the adaptive service, thus facilitating the user in gaining better control over this experience.

3 Use Case / Example

In order to indicate the challenges of this research a simple Use Case, in the context of self-guided adaptive eLearning, is described.

In this Use Case a user, named Sean, wishes to learn more about car engines. Previously he has read about electric motors and he understands the basics of Newtonian physics. In Sean's previous learning he used a personal adaptive service that monitored and adapted the information systems that he engaged with, in order to improve his experience. This adaptive service is available at all times and 'hooks' into the information systems in order to tweak their operation and provide Sean with means to adjust his interests and goals. To achieve this, the adaptive service enables three types of adaptations – modification of content, scrutiny of all adaptive processes and a user modeling portlet. In continuing this Use Case the applicability of each of these adaptations will be highlighted.

Sean browses to a well know internet encyclopedia in order to begin his exploration of the car engine. This website, which may be seen as an information system, exposes a service interface that facilitates a connection to an adaptive service. When Sean logs into the encyclopedia his preferred adaptive service, recorded in his website preferences, is contacted. At this point a portlet, a discrete piece of dynamic web content, which represents his preferences and goals, is integrated into the encyclopedia page. This portlet, representing one of the three adaptation types mentioned earlier, is generated by the adaptive service and gives Sean direct and usable means of controlling what he is interested in. Sean specifies that he is interested in car engines. The adaptive service records this interest as a goal in his user model and uses it to inform and guide the encyclopedia.

As Sean has previously learned about electric motors and Newtonian Physics there are certain topics, in learning about the car engine, which he may skip. The adaptive service has an associated domain ontology that it uses to semantically guide selections in the information service. For example, when starting to read about the car engine, a topic such as ‘torque’ may be hidden, using simple presentation adaptation techniques. This adaptation has been requested by the adaptive service and is implemented within the encyclopedia website. This illustrates the content modification. It assumes that a common semantic understanding exists between the information system and the adaptive service, as well as, a reasonably fine grained mechanism for turning on and off certain pieces of content.

The final type of adaptation, espoused in this Use Case, is that of scrutiny. It may appear very similar to the content modification described earlier, but it relates to the choice Sean made in the user modeling portlet. The modifications made in the user model enact on his behalf. For example, if Sean is not satisfied with what is being displayed, he may turn on the scrutiny feature and view the positions where content was hidden. In this simple Use Case, it will be highlighted, coupled with the adaptive services rationale for hiding it.

If Sean now wishes to use another information system, such as a car manufacturer’s website, the adaptive service will retain his previous preferences and a semantic understanding of what he browsed in order to inform and adapt his experience with this new information source.

4 Conclusion

The above Use Case highlights a very different paradigm for how users currently receive personalised information. It matches closely to the user’s current browsing pattern, i.e. using many different sources, with the difference that the described enriched information systems now communicate and cooperate with a personal adaptive service, which has prior knowledge of the user and an understanding of their goals. This approach has significant implications on the design of the information system and exposes a different methodological approach for adaptation. Service oriented systems, such as APeLS and KnowledgeTree, provide a technological framework that may be suitable for the proposed approach. However, adaptation reference models, such as AHAM!, do not explicitly support this highly semantic

interoperation. Central to the Use Case is to empower the user with a high level of control and feedback. As such, scrutiny is essential in order to ensure the adaptive service can be agile and responsive enough to meet the user's evolving needs.
This Ph.D., still in its early months, will address the engineering of information systems and the associated modifications necessary to service-oriented adaptation approaches. It will do so in the context of a semantically rich interchange of information and instructions between the information system and the adaptive service. This approach, which offers users an unprecedented level of mobility between different information systems, has the potential to bring the benefits of personalization to general web browsing activities.

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