Supporting “Personalisation for All” through Federated User Modelling Exchange Services (FUMES)

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Abstract. The growth of applications as services has been rapid. The emergence of various standards has made it much easier to provide basic levels of service interoperability. However, in personalisation and eLearning services there is the additional challenge of semantic interoperability. This involves the interoperability of services based on the sharing and understanding of explicit knowledge, typically relating to the user. This sharing can be made possible through semantic exchange services which map knowledge about the user from one service to another. This paper looks at an approach to semantic interoperability based on Federated User Modelling Exchange Services (FUMES).

1 Introduction

Technology continues to be embedded in many aspects of our everyday lives. We are now using a wide variety of applications that collect a wealth of information. However, widespread communication between these applications is often limited due to the technological challenges involved. To alleviate this problem, many standards are emerging that allow applications to be implemented as services. This provides common communication protocols which can be used by the applications to exchange information. The interoperability of these services provides great possibilities for the enhancement of user experiences in a variety of applications.

One area where service interoperability can provide significant benefits is in eLearning. Many eLearning applications are now beginning to support these standards as it allows them to cooperate and exchange valuable information. The area of personalisation, in particular, can benefit greatly from the move towards service interoperability in eLearning. Personalisation is a key requirement for eLearning platforms [1]. Providing information tailored specifically to the learner can greatly improve their overall experience [2]. As service interoperability can allow exchange of the learner’s preferences, past history and other related information, the ability to enhance the level of personalisation in current eLearning applications using much richer information becomes possible.

This paper outlines research into these issues and a practical investigation through a system called FUMES. Firstly, there is an overview of the research and the main challenges involved. Following this is an overview of the design and development of FUMES. Finally, some conclusions are drawn about the research and the projected future work is outlined.

2 Overview of Research and Challenges

In the area of eLearning, the dominant applications in recent years have been Learning Management Systems (LMSs). LMSs are suites of tools that provide learners with a means to record, advance and assess their learning. They have become particularly popular in Universities, other third-level institutions and the corporate training sector with many using proprietary systems such as Blackboard (http://www.blackboard.com/), Desire2Learn (http://www.desire2learn.com/) and IBM Workplace (www.ibm.com/software/workplace) or open source alternatives such as Sakai (http://www.sakaiproject.org/) and Moodle (http://moodle.org/). To date, LMSs have typically been monolithic all-in-one solutions not capable of the levels of interoperability and flexibility now
possible. Recently, LMS providers have moved to alleviate this problem by providing support for web services and by creating more modular frameworks in their applications [3][4].

When advanced service level interoperability in LMSs is combined with the area of adaptivity the possibilities for rapid provision of personalised services are numerous. Personalisation is important because it alleviates the “one size fits all” problem [5] from which traditional eLearning suffers while providing learners with increased cognition and reduced learning times [2]. It is an area where the current generation of LMSs are being improved [6] but are still limited. Many independent adaptive services exist such as AHA! [7], KnowledgeTree [1] and APeLS [2]. Providing personalisation services like these to LMS users through standards based service interoperability alleviates the need to integrate them directly into various LMSs, often a complex and repetitive process. Future LMSs are also likely to become completely service based [8] and this approach is aligned with that premise.

Interoperation among services is an emerging field and there are three key issues that arise in this area. First is the provision of technical interoperability. This is the ability for the services to be able to find and access one another. This can be achieved through protocols and standards such as UDDI (http://www.uddi.org/), WSDL (http://www.w3.org/TR/wSDL) and QWL-S (http://www.w3.org/Submission/OWL-S/). The second issue is the ability of the services to interface with each other allowing syntactic interoperability. This means information can be transferred in forms which both services can read successfully using a common functionality.

In LMS and personalisation service interoperability these two aspects combine to provide user model exchange. User model exchange is where the user information in the LMS and the personalisation service is exchanged bi-directionally using service standards as mentioned previously and user model standards such as IMS LIP (http://www.imsglobal.org/profiles/index.html) and IEEE PAPI (http://edutool.com/papi/). However, for more complex levels of user model exchange to take place another level of interoperability is needed.

This third area involves semantic interoperability. This is the ability to interoperate based on a shared understanding of the user. This is a major issue because services have no capacity to understand each other’s information. If this cannot be provided then any information that is exchanged cannot be related to its original context and therefore there can be no assumption of consistency between services. Semantic interoperability is provided by the mapping of the semantics that provide meaning in the services. These semantics are often available in schema formats such as relational database and XML Schema (http://www.w3.org/XML/Schema) and ontology formats such as DAML+OIL (http://www.daml.org/) and OWL (http://www.w3.org/TR/owl-ref/).

Mapping between semantics is a method of relating one segment of information in one service to a relative segment in another service when the segments are represented differently. In a very basic example, a single mapping could relate the user in one service, where they are named “student”, to the user in another service where they are named “learner”. To provide appropriate adaptation to the learner’s needs, personalisation services require detailed information about the learner’s preferences and previous history. This type of information is readily available in LMSs and can be mapped in the same way.

An important question raised by this process is whether these mappings can be automatically generated. When there is a large amount of information to be mapped, fully manual mapping can be a slow and tedious process. Automatic mapping systems do exist [9] but it is likely, however, that the complexity of the information involved in providing high quality personalisation means some level of user configuration will be required. A semi-automatic mapping system [10] where the user oversees the final mappings would be a possible solution.

If these challenges are addressed then the possibilities for extensibility are immense and it will be important to see if the outcomes can develop beyond multiple tools, LMSs and even domains. These are all key challenges that will be examined by the creation of FUMES.

3 Design and Development

FUMES supports both the initial configuration and the runtime interoperation of services. As shown in figure 1, an ideal implementation of this approach would be as an exchange between an
LMS and an external adaptive service. This approach is dependent on both services supporting the emerging IMS Tool Interoperability guidelines (http://www.imsglobal.org/ti/).

The initial configuration consists of the semantic interoperation stage. As shown in figure 1, it is achieved by an administrator selecting the required services in the FUMES interface and, as a result, extracting the user model structure and related schema or ontology from both the LMS and the external service. To allow the user model exchange of rich information, mappings between the user models must be made based on the relational information in the database schema and schema/ontology of the external service. As mentioned previously, a semi-automatic approach is the most likely and consequently, a configuration user interface is provided to allow the administrator to construct the remaining mappings. These mappings are then made available in the form of a transform, used during runtime operation as part of the user model exchange. They are also stored in a repository for future use.

After the initial configuration, FUMES supports runtime operation which is the user model exchange stage. With the semantic mappings fully generated, FUMES has the capability to interpret and exchange rich user information bi-directionally between the selected services. Figure 1 shows an LMS which contains the IMS proxy tool which is part of the IMS Tool Interoperability guidelines. This allows a web interface from an external service to be displayed as a local tool within an LMS. It also passes user identification information back to the external service solving the issue of single sign-on. The external service recognises which user from the LMS is accessing it and initialises an instance of its core engine. This engine creates a temporary model for the known user. The external service then initialises FUMES which extracts the LMS user model in the form of a list of past user events. Based on the mapping transform generated in the initial configuration, FUMES exchanges the information from the LMS model to the external service’s temporary model. When the user is finished their session in the external service FUMES is initialised again and returns the updated user model information for permanent storage in the LMS database. This preliminary method of exchange is static, meaning it is implemented only prior and subsequent to the learner’s session. Future implementations will include active exchange during the course of the learner’s session.

To date, an early prototype applying the concept of FUMES has been achieved. It is implemented using the LMS Sakai and an adaptive simulator called ASPIRE (Adaptive Simulations for Personalised Interactive Realistic Environments) which was designed for teaching communication skills to healthcare professionals. These particular systems were chosen as they provide an ideal setup for investigating this type of approach. Sakai’s architecture is modular in design and it supports web services and IMS Tool Interoperability. ASPIRE supports web services, IMS Tool In-
teroperability and uses IMS LIP for its user model. Sakai displays the simulator using the IMS proxy tool, as outlined earlier, which allows the simulator to appear as a local Sakai tool. Currently, bi-directional exchange of user model information has been achieved based on manually generated semantic mappings between Sakai’s database schema and ASPIRE’s schema. These mappings are defined in a handwritten transform in the form of XSLT (http://www.w3.org/TR/xslt). As this prototype is at an early stage in development, these mappings are relatively basic but ultimately demonstrate the underlying concept.

4 Conclusions

This research introduces a new approach to the idea of interoperating services based on semantics, particularly in eLearning and personalisation. Service based software is rapidly becoming more widespread and the field of eLearning is quickly adopting this approach. Particularly in LMSs, service based software will likely become very important. As mentioned previously, FUMES is aligned with envisioned future generations of LMSs that will break up functionality into a collection of interoperating services. FUMES would then provide a possible means of exchanging detailed knowledge seamlessly between these multiple and varied services in the LMS. FUMES is also standards based and this is central to successful interoperability and extensibility into other areas outside of eLearning.

There is still significant work to be done to complete FUMES but the basis for a successful implementation has been achieved. Future work will include the completion of more complex mappings in the prototype system. This will include examining what additional information in the LMS database can enhance the current level of personalisation provided by ASPIRE. Following on from this, a graphical user interface will be used to create the mappings and a semi-automatic approach to the creation of these mappings will be applied. This area will most likely involve some of the mapping tools and algorithms that are freely available for use [9] [10]. Using these mapping tools and algorithms to produce partial mappings that will be completed by the administrator is an important goal of FUMES. Another important aim will be advancing the preliminary method of exchange from being static to being active during the course of the learner’s session.

Ultimately, the evaluation of FUMES will be a key issue. There are several areas where it can be tested such as performance, ease of use, reliability and consistency of information with a range of external adaptive services. FUMES could also be tested using other LMSs such as Moodle. The quality and level of automation of the generated mappings and consequently, the levels of the personalisation from the user information in LMSs are other areas that will provide rich opportunity for examination.
References


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