Lowering the Barriers to User Model Interoperability

Eddie Walsh and Vincent Wade

Knowledge and Data Engineering Group,
Intelligent Systems Lab, School of Computer Science and Statistics,
Trinity College Dublin, Dublin 2, Ireland
{walshe8, Vincent.Wade}@cs.tcd.ie

Abstract. As people start to use many applications that require rich forms of user information, being able to share the contents of user models has become important. However, there are significant challenges in providing advanced levels of interoperability as user models are often very diverse in structure, syntax and semantics. This paper introduces FUMES; an approach to user model interoperability between heterogeneous educational applications. The aim of FUMES is to lower some of the common barriers to user model interoperability. It attempts to reduce the technical knowledge and domain expertise required from a human administrator of this process through the provision of domain-specific tools that include novel user model visualizations.

Keywords: User Model, Interoperability, Exchange, Sharing, Semantics, Mapping, Visualization.

1. Introduction

Intelligent applications are now emerging that are dependent on having rich forms of user information. This, combined with the trends towards ubiquitous computing environments and service-orientated architectures, means automatically sharing the contents of user models across system boundaries has become essential [1].

However, achieving advanced levels of user model interoperability is a difficult and complex task [2]. Many issues arise that are well-known in established research fields such as databases, XML and ontology integration. One of the most difficult challenges to resolve is semantic heterogeneity [3]. Systems are designed by different people and this leads to the use of different vocabularies and perspectives in schema and instance data which can be difficult to reconcile.

To help reduce semantic heterogeneity in user models, mappings are often created between equivalent user data [3]. As this is a complex process that cannot be done completely automatically, an administrator is usually heavily involved in the creation of these mappings. This often requires the use of some of the established generic schema or ontology-based mapping tools. These tools can be difficult to use in many situations, are often unnecessarily complex for this task and generally do not provide the benefits that are possible from operating in a restricted domain area such as user models [4].

This paper introduces an approach to user model interoperability in the educational domain called FUMES (Federated User Model Exchange Services). FUMES attempts to make the difficult task of sharing a user's educational information between disparate sources easier to implement and to manage for an administrator through the use of specialized tools. The FUMES framework consists of various components to provide a comprehensive user model sharing process. However, this paper focuses primarily on the Administrator Application for human input to the interoperability process. FUMES is briefly outlined and the Administrator Application is discussed, including the plans for a novel, user model mapping visualization.

2. FUMES

FUMES is realized in the form of a web service-based framework and supporting tools as shown in Figure 1. Initially, the framework supports user models in XML form although in the future this may be extended to include semantic web technologies such as RDF and OWL. The two key supporting tools are the Administrator Application and the Translation Service.

The Administrator Application allows an administrator, in an initial setup stage, to manually create mappings and management settings for the sharing of distributed application's user models. The Translation Service, in a runtime stage, provides access to the distributed user model instances and performs the execution of the exchange process. The Translation Service controls this process by utilizing the mappings and management settings created by the Administrator Application.

The combination of these applications allows FUMES to automatically share user information between multiple concurrent applications using web services. In the following sections, the Administrator Application is discussed in more detail.

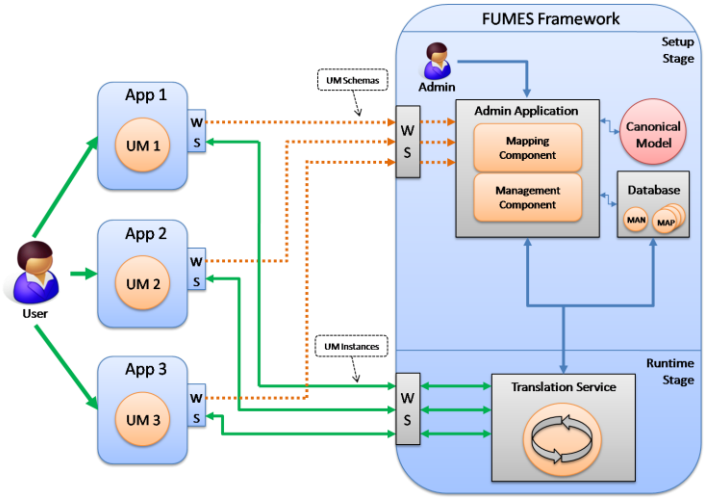

Figure 1: FUMES Framework & Supporting Tools

2.1. FUMES Administrator Application

The FUMES Administrator Application, currently under development, is the central location for an administrator to perform the required manual tasks for successful exchange of user information. It consists of two parts; the mapping component and the management component.

The mapping component can be used to graphically resolve semantic differences between education-based user models. It adopts a fully manual process for mapping determination with the emphasis being placed on better visualization for the administrator. Mappings are created from each application schema to an extendable IMS LIP-based canonical model [5] using the graphical interface. The mapping component automatically generates executable XQuery [6] versions of these mappings which are stored in the FUMES database. These mappings can then be retrieved and combined as needed by the Translation Service when exchanging instance data between user models.

Some examples of mappings that can be created between user models include basic string and numeric manipulations. Date mappings can covert between the various date formats used in different systems. Grading mappings can be used to specify equivalences between different grade formats such as percentages and letter grades. Generic instance mappings can also convert between matching instance data.

In the Administrator Application, the mapping component is also coupled with a management component to control the flow of user information. The management component allows the administrator to graphically specify which applications are sharing with each other, set precedence of user models to reduce the issue of overlapping information and to set default user models inputs to reduce the issue of incomplete user models. The management settings are stored to the database and retrieved by the Translation Service to determine the appropriate exchange process.

2.2. User Model Mapping Visualization

The next stage of this work will involve the design and development of a novel domain-specific visualization for the mapping component of the Administrator Application. The visualization will attempt to provide the best solutions for displaying the FUMES canonical user model, displaying imported user models schemas from heterogeneous sources, and displaying complex mappings between those user models.

In FUMES, the canonical model is based on IMS LIP which is a comprehensive description of learner characteristics. However, attempting to make mappings to IMS LIP can be difficult due to its large size; it consists of a hierarchical structure that contains several hundred data elements in total [5]. As a result, the administrator has to negotiate a complex array of nodes and must be very experienced with IMS LIP in order to map successfully. One of the main goals for the new visualization is to reduce the requirement for the administrator to be experienced in IMS LIP. The explicit view of the entire canonical model will be replaced by user-friendly icons that represent different sections. The administrator can then select icons as opposed to negotiating the tree-view to find the exact section of IMS LIP required.

Visualizing the imported user model schemas will be a significant challenge as this will need to support different types of user models. The use of icons would be difficult in this situation as the user models will be changing regularly and new user models will be added often. A generic visualization such as a tree or graph view may prove to be the best solution in this situation.

The visualization for the creation of the mappings will also be implemented using icons to further simplify the process. These could represent the commonly created mappings types outlined earlier; for example, string-based, date or grading mappings. The use of mapping type icons combined with the icons for the canonical model would greatly simplify the mapping procedure for an administrator.

Overall, FUMES will include a novel approach to the visualization of the user model mapping process. It will present a domain-specific and symbolic representation of complex underlying user model data. It will be web-based, dynamic and user-friendly and will reduce the cognitive load on the administrator by only displaying the information that is needed at the time, hiding unnecessary information. Support for the administrator will be included in the form of detailed instructions for each step of the process and detailed descriptions of each section of the canonical model. Additional user aids will include a visual overview of each mapping as it is being created and a summary of the previously created mappings.

3. Conclusions

The FUMES approach attempts to lower some of the common barriers to user model interoperability that currently make it a complex task that can only be performed by experts with a range of specialist skills. FUMES will provide tools that are domain-specific and include visualizations that present a symbolic representation of complex underlying data. The objective is a reduction in the technical knowledge and domain expertise required from an administrator. While this work is still evolving, the overall goal is to utilize this user-centered approach to build a practical solution for user model interoperability that is applicable to a wide range of existing applications.

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