

Adaptive Personal Information Environment based on the Semantic Web

Thanyalak Maneewatthana
IAM Group,

School of Electronics and Computer
Science

University of Southampton
Southampton, SO17 1BJ, UK

tm03r@ecs.soton.ac.uk

Gary B. Wills
IAM Group,

School of Electronics and Computer
Science

University of Southampton
Southampton, SO17 1BJ, UK

gbw@ecs.soton.ac.uk

Wendy Hall
IAM Group,

School of Electronics and Computer
Science

University of Southampton
Southampton, SO17 1BJ, UK

wh@ecs.soton.ac.uk

ABSTRACT

In order to support knowledge workers throughout their task of searching, locating and manipulating information, a system that provides information suitable for a particular user's needs, and that is able to facilitate the sharing and reuse of knowledge is essential. This paper presents Adaptive Personal Information Environment (a-PIE); a service-oriented framework using Open Hypermedia and Semantic Web technologies to provide an adaptive Web-based system. a-PIE models the information structures (data and links), context and behaviour as Fundamental Open Hypermedia Model (FOHM) structures which are manipulated by using the Auld Linky contextual link service. a-PIE provides an information environment that enables users to search an information space based on ontologically defined domain concepts. The users can add and manipulate (delete, comment, etc.) information of interests or part of an information structure in their information space, leaving the original published data or information structures unchanged. The a-PIE environment facilitates the shareability and reusability of knowledge according to users' requirements.

Categories and Subject Descriptors

H.3.5 [Online Information Services]

General Terms

Design, Management.

Keywords

Ontology, link services, adaptive hypermedia.

1. INTRODUCTION

Knowledge management and associated tools aim to provide an environment in which people may create, learn, share, use and reuse knowledge, for the benefit of the organisation, the people who work in it, and the organisation's customers. However,

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instead of helping users, many systems are just increasing the information overload and adding to users feeling of being lost in hyperspace. Adapting text and sets of relationships of information or contents to the needs of individual users greatly enhances navigation and comprehension of information spaces.

Web services provide a standard way for various existing applications running on heterogeneous resources or frameworks to interoperate [1]. The Semantic Web can be used to organise information in concept structures, while Web services allow the encapsulation of heterogeneous knowledge and modularization of the architecture. In addition, Web services also support dynamic and shareable frameworks for automated adaptation [2]. The key idea of the Semantic Web is to have data defined and linked in such a way that its meaning is explicitly interpretable by software processes rather than just being implicitly interpretable by humans [3]. An ontology is a means to formally describe a shared understanding, model and capture knowledge for a particular domain [4]. An ontology can be used to enrich the semantics of data and information structures to aid the processes of information searching (use and reuse of information).

In this paper we propose an Adaptive Personal Information Environment system (a-PIE), a service-oriented framework for reusability and shareability of information. a-PIE aims to provide a system in which members of the community are able to browse information tailored to their needs, store relationships to content of interest in their own information repository, and are able to augment it for reuse.

The background of related technologies; The Fundamental Open Hypermedia Model (FOHM), Auld Linky, Semantic Web, and Web services are briefly described in the next section. The related works are presented later. Then, a system overview of a-PIE is presented, focusing on the support for adaptation, reusability and shareability of information. Finally some conclusions and future work are presented.

2. BACKGROUND

The Fundamental Open Hypermedia Model (FOHM) [5] is a protocol with additional context-awareness features for open hypermedia. FOHM is a data model for expressing hyperstructure by representing associations between data. The four essential components of a FOHM structure are Data objects, Associations, References and Bindings. Data objects are wrappers for any piece of data that lies outside of the scope of the FOHM model. Associations are structures that represent relationships between

Data objects. Reference objects are used to point at Data objects or at parts of Data objects. Bindings specify the attributes of the connection between Association and Data objects. Two modifier objects, Behaviour and Context, can be attached to any part of a FOHM structure. Behaviour objects are used by client applications to action events, whereas Context objects can define in what circumstances to make available a particular object.

Auld Linky is a context based link server which supplies links from specified link databases (linkbases) by parsing FOHM linkbases. Auld Linky uses the description types from Context objects to identify which bindings should be returned.

This work is inspired by the Conceptual Open Hypermedia Services Environment (COHSE) [6]. The purpose of COHSE is the integration of an open hypermedia architecture, especially the Distributed Link Service, with ontological services to support an architecture for the Semantic Web and provide the linking based on the concepts that appear in Web pages. The documents are linked via metadata attached to documents. However, there is no adaptation of the links and contents in this approach. In addition, De Bra *et al* propose a *modular adaptive* hypermedia architecture for adaptive Web-based systems. Each system component communicates through service invocations as Web services to enhance flexibility. Ontologies are used to define the system's vocabulary and the properties of each system service [2]. a-PIE adds adaptive functionality to the link services by using FOHM models. It uses Semantic Web technology to define concept structures and facilitate interoperation between system components, which are implemented as Web services.

3. SYSTEM OVERVIEW

Community portals are information portals designed to support and facilitate a community of interest. They allow members in a community to contribute information either by submitting (posting) it to the system.

a-PIE aims to provide a system in which members of the community are able to browse information suitable to their particular needs, identify and store FOHM structures in their own information repository which users may enhance prior to reuse. This system improves these functionalities by using ontologies to define system components.

3.1 Data storage and adaptation

In order to promote reusability, sharability and adaptability of links and data contents, a-PIE separates system components into models; domain concept, data, structure, presentation, user information, context and behaviour. Each model uses an ontology as a means by which to interoperate.

- *Domain concept model*: the basic structure of the concept schemas. Simple Knowledge Organisation System (SKOS) [7] is used to express the basic structure of concept schemes.
- *Domain data model*: the data created and stored by the individual or organisations on their own Web site. This is stored in the form of FOHM Data objects.
- *Structure model*: connects FOHM Data objects into a collection of FOHM Association structures. FOHM Association structures can be used to model several hypermedia structures; Navigational Link, Tour, Level of Detail, and Concept.

- *User model*: represents user-related information, such as background knowledge, preference, or information about the user.
- *Context model*: FOHM Context objects which can be attached to a Data or Association object for describing the context in which the data item or association is visible to or hidden from the user.
- *Behaviour model*: FOHM behaviour objects which can be attached to a Data or Association object, Behaviour objects describe an action that occurs as a result of an event.
- *Presentation model*: displays and machine-related information, such as the colour schemes for resource presentation.

a-PIE supports adaptive hypermedia system as it uses Auld Linky [5] as a contextual link server to integrate FOHM structure and data objects according to the context. Brusilovsky's taxonomy of adaptive hypermedia techniques [8] categorises a number of techniques under two main subcategories; adaptive navigation and presentation. FOHM structures can be combined to implement a range of techniques represented in the taxonomy [9]. Therefore, a-PIE, which uses FOHM and ontological hypertext, can produce the information appropriate to users' needs as an adaptive Web-based system. Once the data file is made available by the organisation and published through the Web site, other users can use, reuse, or browse through browsers. This means that anyone with an Internet connection can use and reuse the information.

3.2 Reusing, sharing and enriching the information

In Open Hypermedia links are first-class objects and manipulated independently. Open Hypermedia makes links (associations) between different pieces of information (e.g., images or text). Hypermedia link-types describe the associations. Therefore, hypermedia link-types are knowledge relations [10], and a set of hypermedia link types may be represented as an ontology.

Reuse and sharing of knowledge is an integral aspect of the Semantic Web. In a-PIE, the ontology is based on Semantic Web technology standards (RDF/OWL) and is the backbone of the system. The ontology represents relationships of domain concepts. A *link types* ontology has been created based on relationships suggested by Bieber and Yoo [11]. The ontologies are also used to define user models, enrich links and data content, and to enable other users or organisations to reuse and share the content or structure of the FOHM representation. Each user in a community or organisation can browse and search the site. In addition, the user can add data (or other additional information) and change the context (or behaviour) of a specific piece of data or FOHM structure. The users might use their own domain concepts, context or behaviour for categorising or describing the information.

3.3 Implementation

Figure 1 illustrates the system architecture of a-PIE. The functionality of the system is made available to software agents through a Web service interface, and to end-user through a Web browser interface.

The system consists of several services; domain concept service, structure and data service, user model service, Linky service, presentation service, user service (adaptive engine), and composer service (see figure1). The domain concept service provides the

relevant concept. The user model service updates user model. The structure service manipulates data and structures (links) as FOHM objects from linkbases through the Linky service. The user service (or adaptive engine) provides the facilities for reconciling the content, structure, user, and presenting the individualised document to the user through a Web browser.

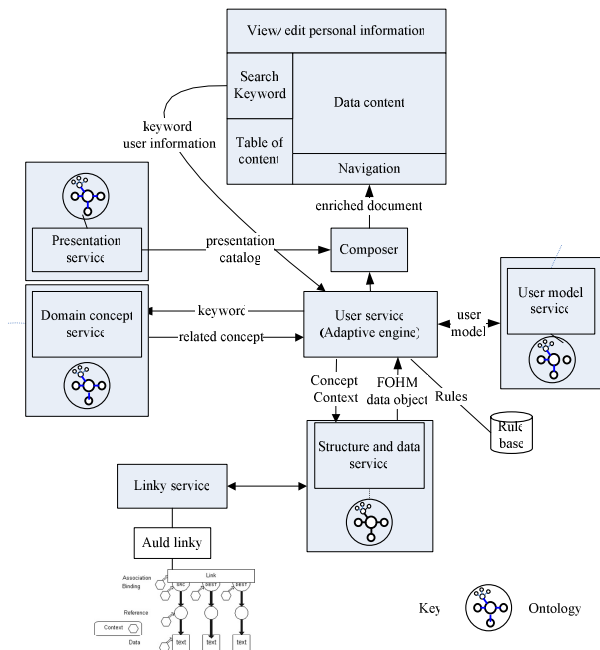


Figure 1 a-PIE System Architecture

4. CONCLUSION

This paper describes a semantically driven approach for an adaptive information environment to support knowledge workers. The proposed system, a-PIE, is based on the Semantic Web. a-PIE provides an information environment for users in a community or organisation to browse or search information based on domain concepts defined by ontologies. The users are also able to manipulate their own information space by adding or deleting information chunks or any part of an information structure, into their information space. In addition, they can add, edit or delete personal information such as comments or notes to the existing data or information structures while the original data or information structures published to the Web-server are unchanged.

The adaptation, reusability and shareability of information components in this system is achieved by using Semantic Web technology, and by storing separately the data, information structures, domain concept, context, behaviour, presentation and user information models. The data, information structure, context and behaviour are represented by FOHM object models and manipulated by using Auld Linky, a contextual link service. The ontologies are used to define common explicit relationships for domain concepts and to enrich data, information structures,

presentation and user models. a-PIE, which uses FOHM and ontological hypertext, can produce the information appropriate to users' needs as an adaptive Web-based system. Moreover, a service-oriented framework is used to provide the loosely coupled and reusable software components.

Future work will focus on developing methods for users to interact with the information of interest and for the system to return a set of relevant concept links, such that the users can reuse and share this new information with colleagues. Moreover, it is possible to provide multiple aggregations and views of the same data in different contexts.

5. ACKNOWLEDGEMENTS

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