

Personal Digital Librarian: An Adaptive System and Framework using Semantic Web Technologies

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Abstract

Personal Digital Librarian(PDL) is a book recommendation and management system. PDL can recommend books which will interests individual users, and can also manage the books a user owns. PDL is built on a framework called “Adaptation Anywhere & Anytime”(A3). A3 uses semantic web technologies, and provides systems built on A3 such as PDL with adaptable functions. PDL uses these to recommend and manage books.

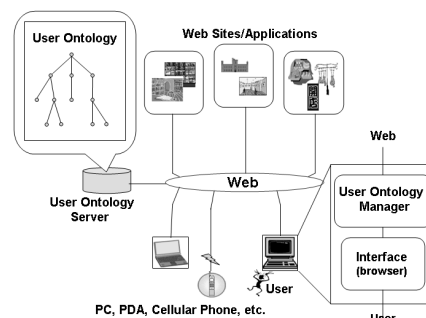


Figure 1: Overview of A3 framework

1 Introduction

Today, we can obtain data from various information systems. Each systems has a large quantity of information that can be delivered to users. However, it can be difficult to locate information appropriate to individual users. Therefore, an adaptivity is becoming increasingly important for locating and presenting appropriate information.

Personal Digital Librarian (PDL) is an adaptive system that we have developed. PDL has two main functions: book recommendation and management. PDL can recommend books which will probably interest individual users according to each user's interests. Also, PDL manages the data of books that the user already owns. For example, PDL can retrieve book data from all of the user's books and so on.

PDL is built on a framework called “Adaptation Anywhere & Anytime” (A3)[kanjo *et al.*, 2004]. A3 uses semantic web technologies, and provides systems built on this framework with adaptation functions, for example, a function for acquiring user profiles. Systems built on A3 can use these functions to adapt their output to each individual user. PDL also uses these functions to select an appropriate book, make user profiles, and so on.

2 A3 Framework

Figure 1 shows an overview of A3. Many kinds of adaptive system can be built on A3. A user can employ any system built on A3 from various devices such as PCs, PDAs, etc. through the web. Each system can adapt its output to individual users by implementing functions provided by A3. To enable use of these functions, A3 provides simple methods using XSLT[Clark, 1999] or JSP technologies.

To achieve an adaptation, a user profile is needed. In A3, this is represented by an ontology called “*user ontology*”. A user ontology is a classified tree consisting of resources

and categories. In this study, a user ontology is defined as a representation of each user's knowledge. A resource is information which represents an object such as merchandise on an e-shopping site, a news article on a news portal site etc. Each resource is categorized into one specific category. A category has restrictions representing the attribute which the categorized resource must have. We assume that Semantic web is reachable. Then, resources and their attributes are written by RDF/S [Brickly *et al.*, 2004] and OWL [Dean *et al.*, 2004]. User ontologies are also written by RDF/S and OWL. This makes it for user ontologies and resources to be used or shared by any system on A3.

Each user has their own user ontology, which serves as the user's profile. A user ontology is automatically constructed based on the interaction between the user and the system. For example, when a user enters data for a resource, it can be assumed that the user has knowledge about the resource. Then, the resource is categorized into an appropriate category of the user's ontology. If necessary, the user ontology is reconstructed, for example, a new category is made or existing categories might be moved to a suitable position. User ontologies can be shared by all systems on A3. Any system can share user ontologies constructed by another system to adapt its own output for users.

Automatic construction and sharing of a user ontology resolves some conventional problems of adaptive systems such as differences in the adaptive precision between systems and so on. On the other hand, other problems regarding user privacy and the consistency of user ontology will arise. To resolve these problems, all manipulations concerning user ontologies are performed by **User Ontology Manager** (UOM) in A3. Resources, which should be de-

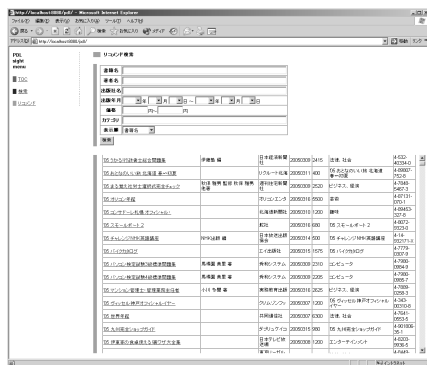


Figure 2: The PDL interface

livered to the user are selected with UOM. UOM can calculate the weight of a resource based on the user ontology. The weight represents the strength of the user's interest in the resource. A resource with a large weight will probably be more interesting to the user than the one with small weight. Additionally, UOM can construct a user ontology by adding a resource. The added resource is categorized into an appropriate category, and a user ontology is constructed. Thus, all manipulations on user ontologies are performed by UOM. So users' privacy and the user ontology consistency are maintained.

An another main component of A3 is **User Ontology Server (UOS)**. UOS stores user ontologies while a user is not using a system. When a user begins to use a system built on A3, UOS sends his/her user ontology to UOM. When the user finishes using a system, the user ontology is returned to UOS. Thus, the same user ontology is reused or shared between systems.

3 Personal Digital Librarian

Personal Digital Librarian (PDL) has two main functions: managing the data of a user's book collection, and recommending books. PDL uses functions provided by A3 for book recommendation and management.

Figure 2 shows the PDL interface. The PDL's functions are listed on the left. The right section is used for delivering results. This example shows the result of a recommendation. The user can specify conditions for a recommendation, and enter them in upper right section. The recommendation results are presented in the lower right section.

[Book management]

PDL provides the user with functions for managing the data of the user's book collection, for example, sorting and retrieving books, etc. To perform these functions, the user must enter data for the books that he/she owns.

When the user enters book data, PDL assumes that the user has acquired knowledge about the book and proceeds to construct his/her user ontology by adding the book as a resource. This constructed user ontology is used as a user's profile in the recommendation process. Furthermore, the user ontology constructed by PDL can be used by another systems as a user profile.

[Book recommendation]

The target books for recommendation are published while the user is not using PDL. The data of such books can be retrieved from web pages such as "Yahoo books!"

(<http://books.yahoo.co.jp>, Japanese).

PDL first makes a book list containing all the target books, and then removes books which do not satisfy the conditions the user enters. Next, PDL send this list to UOM. Then, UOM considers each book as a resource, and calculates a weight for each book. Books are sorted according to their weight. Books with a larger weight are presented earlier than ones with smaller weight. The user can get detailed information on a book that looks interesting by clicking its title. If the title is clicked, more detailed data is presented. In addition, when the title is clicked, PDL assumes that the user will be able to acquire knowledge about the book and passes the book data to UOM. Then UOM adds the book to the user ontology and reconstructs the user ontology, if necessary.

The functions provided by A3 are easily used by systems using XSLT or JSP technology. For example, the recommendation can be achieved by embedding the following JSP program into an HTML document.

```
http://www.a3host:port/a3/recommend.  
jsp?doc=http://www.pdlhost/books.xml
```

If this JSP program is executed, resources that are contained in XML document will be ranked and presented. The XML document is specified by the argument `doc`. This document must contain the list of target resources. In PDL, the XML document specified by <http://www.pdlhost/books.xml> must contain the book list. So, PDL or the builder of PDL must make the XML document. The resources contained in this document must satisfy the conditions that the user specifies.

4 Conclusion

We developed Personal Digital Librarian (PDL), which is an adaptive system built on "Adaptation Anywhere & Anytime framework" (A3). PDL can recommend books which will probably interest a user, and can manage the data of books that the user owns. A3 provides PDL with functions for selecting books which should be recommended, and for acquiring the user profile(user ontology), etc. PDL is just one example of an adaptive system which can be built on A3. We must now build other systems and verify them.

References

- [Brickly *et al.*, 2004] Brickley,D.,Guha,R.V., RDF Vocabulary Description Language 1.0:RDF Schema, <http://www.w3.org/TR/rdf-schema/>
- [Clark, 1999] Clark,J., XSL Transformations(XSLT) Version 1.0, <http://www.w3.org/TR/xslt>, 1999
- [Dean *et al.*, 2004] Dean,M., Connolly,D., Harmelen,F., Hendler,J., Horrocks,I., McGuinness,D., Schneider,P., Stein,L., OWL Web Ontology Language Reference, <http://w3.org/TR/owl-ref/>.
- [Dolog and Nejdl, 2003] Dolog,P.,Nejdl,W., Challenges and Benefits of the Semantic Web for User Modeling, *Adaptive Hypermedia and Adaptive Web-Based Systems*, 2003
- [kanjo *et al.*, 2004] Kanjo,D.,Kawai,Y.,Tanaka,K., Ontology based Framework for Adaptive Web System, *Workshop I:Enterprise Modeling and Ontology: Ingredients for Interoperability*, in *Intl. Conf. of Practical Aspect of Knowledge Management*, 2004