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Services Provided by Digital Libraries: Current Status and Future Strategies
Chen Jiangping
School of Library and Information Sciences, University of North Texas, Denton 76203

[Abstract] This paper analyzes personalized services and social computing tools in current digital libraries to achieve a general understanding about services they provide. An examination of 29 digital library websites reveals six types of personalized services provided by 31% of the sample libraries: personalized email notification, personalized interface, search action or history, links, personalized bibliography, and peer-to-peer facility or recommendation. Five social computing tools are also examined. Personalized services and social computing tools have great potential to increase the functionality and usability of digital libraries. It is suggested that further research should determine optimized implementation strategies and understand the effects of personalized services and social computing tools.

[Keywords] digital libraries personalized services recommender systems social computing

1 Introduction

The development of digital libraries reflects a long-held desire for convenient knowledge sharing and fast information access. Advances in computing and network technologies, especially Internet technologies, make it possible to store large volumes of information in different formats and to access the information whenever and wherever it is needed. Often funded by governments and institutions, more and more digital libraries are being launched and put into use.

Many current digital libraries are more like traditional information retrieval systems that provide search and browse functions as the major services to their users. Few systems provide virtual reference services that enable users to submit their questions to a reference librarian or a domain expert through emails or HTML forms. How to encourage the use of digital libraries and to increase user satisfaction with the systems are important research questions for the digital library community, especially in light of competition with Web search engines such as Google. The future of digital libraries depends greatly on how the community can address these questions.

While exploring new approaches to improving the use of digital libraries, the author has learned that there are at least two directions to consider: one is personalized services including recommender systems, and the other is the application of social computing tools.

Personalized services refer to appropriate ways through which information can be customized to satisfy the unique needs of the individual users of a digital library system[1]. Recommender systems can be considered as a special type of personalization in which information that meets the needs of a user is identified and recommended to him/her based on the knowledge the system has about that user. Personalized services are not uncommon. For example, when using e-commerce systems such as Amazon.com and Target.com, customers are provided information regarding what others products were also purchased by people who bought a particular product.

Social computing is the term for the use of social software as an intermediary or a focus for social relations in computing applications[2]. Social software refers to those computer tools that support social
interaction and collaboration. They allow individuals to communicate with one another, and/or to track discussions on a particular topic. Social software, as defined above, is not totally new—it has existed for decades in forms such as email, mailing lists, instant messaging, online role-playing games, and even collaborative editing tools. New forms of social software include forums, blogs, and wikis. Those new technologies are changing the way people use and perceive the Internet as well as the way they work and play.

What can personalized services and social computing do for digital libraries? What is the current status of services provided by digital libraries? Have digital libraries incorporated certain kinds of personalized services or social computing in their systems? The author believes that answering these questions is important as the answers may lead to solutions for increasing user satisfaction with the digital libraries. Therefore, this paper aims to find answers to the above questions through an analysis of the current websites of 29 digital libraries.

The paper is organized as follows. First, related literature on digital libraries services and the applications of personalized services and social computing are reviewed. Then, the purpose of this study is presented along with the selection of the sample digital libraries and their characteristics. Next, the results of the analysis are presented and the possible benefits of integrating appropriate forms of personalized services and social computing into digital libraries are discussed. The paper concludes with future research issues relevant to the implementation of personalized services and social computing in digital libraries.

1.1 Related literature on digital libraries services

Digital libraries are complex systems that include various functionalities and interactive elements. They are more than just websites or collections of documents or other forms of information. To improve the effectiveness of digital libraries, researchers have explored strategies such as designing user-friendly user interfaces, flexible search and browsing functions, iterative query refinement, and reference services. These strategies allow users to better interact with the digital library systems.

Personalized services are quite common in web systems. For example, the Yahoo.com homepage shows the weather information of the city a user lives. My.unt.edu (http://my.unt.edu) provides the faculty at the University of North Texas with customized information regarding the courses they are teaching. Many libraries also provide personalized services, often titled Mylibrary, such as the Mylibrary service at Cornell University Library and MyLibrary at Los Alamos National Laboratory.

Personalized services have also been explored to satisfy diverse needs of digital library users. Early research on personalized services in digital libraries used simple user models to make individual recommendations. The personalization can be based on different criteria that matter to the users. For example, the source of the information and the subject areas of the users can be used by a digital library for personalization. Frequently, personalized services in digital libraries have been driven by the users, i.e., the user specifies his or her preferences or requirements directly to the system.

A more advanced approach to providing personalized services in digital libraries would be to develop automatic user models and to refine those models while using them. Frias-Martinez, Chen, and Liu applied different classification systems to automatically identify the cognitive styles of users of a digital library. They conducted experiments with different approaches in order to automatically construct the user models to capture the user's cognitive style.

Recent recommender systems provide recommendations based on the activities and preferences of user groups or communities. Callan and colleagues considered those systems as a server-based form of personalization that was different from the client-based personalization, which focused on building a detailed model of an individual user. They over a variety of tasks and over a lifetime of use. Research is greatly needed to bridge these two systems and to develop flexible hybrid models.

As previously mentioned, new forms of social software such as forums, blogs, and wikis have received increasing attention in recent years and have been used in knowledge management and sharing, collaborative editing and documentation, and storytelling. They have signaled the eventual arrival of a new phase of the Internet called Web 2.0.

Blog, a term coined by Barger in 1997 is, “a Web page where a web logger ‘logs’ all the other pages she finds interesting.” Nardi, Schiano, Gumbrecht, and Swartz conducted an ethnographic investigation of blogging in and around Stanford University in order to uncover reasons behind blogging. They identified five major motives for blogging: documenting one’s life, commenting and providing opinions, expressing strong emotions, publishing ideas, and establishing and maintaining community forums. People use blogs to express ideas and to comment on topics they consider important and pertinent.

Wikis are interactive web sites to which users can add new pages or content. The first wiki was created by Ward Cunningham in 1993 for the purpose of publishing information collaboratively on the Web. The most popular wiki on the Internet may be the Wikipedia—the free encyclopedia (http://en.wikipedia.org/wiki/Main_Page). This technology is now being adopted by many organizations as a
collaborative tool for knowledge management\(^{19}\).

So far, little literature has been found addressing the application of social computing in digital libraries. Frumkin\(^{16}\) looked at how collaborative tools, such as wikis, can be utilized in a digital library environment and identified three potential applications: a knowledge base tool, a content management tool, and a tool to empower interactive finding aids. Teng and Wang\(^{17}\) conducted a study to investigate university students' perceptions of the usefulness of blogs as a learning tool in higher education and suggested that digital library designers could learn from blogs to create a dynamic and socially-trusted learning environment.

1.2 Purpose of the Research

The literature shows that research on personalized services and social computing is limited. It is thus unclear what personalized services and social computing have been integrated into practice in digital libraries that have been open to the public. In this study, an analysis of the websites of 29 sample digital libraries was conducted. The purpose was to achieve a better understanding of the current status of the services provided by digital libraries. Specifically, the author would like to understand what and how personalized services and social computing have been implemented by current digital libraries.

The author believes that identifying which personalized services and social computing have been employed in active digital libraries is the important first step towards developing and evaluating new personalized services or social computing tools in digital libraries. The ultimate goal is to promote the use of digital libraries and to increase the satisfaction of digital library users.

2 Sample Digital Libraries

To conduct the analysis, the first task was to select a sample of digital libraries for analysis. To determine whether a website is a digital library, the author applied the definition given by the Digital Library Federation (DLF) (http://www.diglib.org/about/dldefinition.htm):

Digital libraries are organizations that provide the resources, including the specialized staff, to select, structure, offer intellectual access to, interpret, distribute, preserve the integrity of, and ensure the persistence over time of collections of digital works so that they are readily and economically available for use by a defined community or set of communities.

Based on that definition, a digital library should possess the following characteristics: ① Contain digital collections that may contain digital objects in different formats; ② Organize and manage digital collections; ③ Contain human (librarians) as well as technological resources; and, ④ Provide efficient and effective information access and services to a defined community or set of communities.

Because there are so many digital libraries on the Web and a complete list of existing digital libraries is not available, it is truly difficult to make the selection. A multi-step process was followed to select the final list of sample digital libraries.

First, the author looked at the digital library projects funded by the National Science Foundation (NSF) Digital Library Initiative Phase One (http://www.dli2.nsf.gov/dlione/) and Phase Two (http://www.dli2.nsf.gov/). As many projects are not actually themselves digital libraries but research on issues related to digital libraries, only 10 digital libraries following the links from the above two pages were identified. Then, the Registry of Open Access Repositories (http://roar.eprints.org/) was examined and 27 U.S. open access repositories that have record counts larger than 5000 were extracted. Many of those repositories are institutional repositories. Finally, the author selected digital libraries that appeared in the literature -either in a subject domain of the author's interest, or because they contain multimedia objects. In total, a pool of 54 digital libraries was obtained.

Next, each digital library in the pool was checked and 29 representative and active digital libraries were chosen as the finalists for analysis. Here "representative" means the selected digital libraries embody certain types of digital libraries with the same characteristics. "Active" means these digital libraries have been completely constructed and opened to the public or to certain user communities. Digital libraries that are still under construction were not selected. Table 1 is the list of the 29 sample digital libraries. As seen in Table 1, each digital library has been assigned an ID for easy referral in subsequent tables in this paper.

Table 2 summarizes the basic characteristics of the sample. Among the 29 digital libraries, 5 were founded by the NSF or other federal agencies such as The Institute of Museum and Library Services (IMLS), National Aeronautics and Space Administration (NASA), or National Endowment for the Humanities (NEH). Of the sample, 7 contain multimedia digital objects such as images, moving objects, or audios in addition to texts; 9 are institutional repositories that allow employees to submit their articles or works. Three digital libraries (the International Children's Digital Library, the European Library, and the Perseus Digital Library) provide multilingual interfaces. Of the 29 digital libraries, 4 are associated with one or more physical libraries. About 45% of the sample are domain-specific digital libraries that focus on collecting digital objects and providing information access in a particular subject area.
3 Personalized Services in Digital Libraries

The analysis identified what personalized services and social computing have been implemented in the sample digital libraries. A careful examination of the websites of the sample digital libraries revealed that only 31% (9) have implemented some type of personalized services. Table 3 presents the analysis of the six services provided in those 9 libraries, followed by a brief explanation of these results.

Table 3 Personalized Services in the Sample Digital Libraries

<table>
<thead>
<tr>
<th>Type of Services</th>
<th>Frequency</th>
<th>IDs of the Digital Libraries that provide the service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personalized email notification</td>
<td>3</td>
<td>8, 10, 17</td>
</tr>
<tr>
<td>Personalized interface</td>
<td>2</td>
<td>13, 28</td>
</tr>
<tr>
<td>Search or action history storage and display</td>
<td>2</td>
<td>22, 23</td>
</tr>
<tr>
<td>Personalized links</td>
<td>5</td>
<td>22, 23, 24, 25, 28</td>
</tr>
<tr>
<td>Personal bibliography</td>
<td>1</td>
<td>24</td>
</tr>
<tr>
<td>Peer-to-peer facility or recommendation</td>
<td>1</td>
<td>24</td>
</tr>
</tbody>
</table>

3.1 Personalized email notification

Three digital libraries (10.3%) allow users to provide and save search queries so that the systems can send email notification or alerts when new contents that match the queries are collected. The users can set the frequency with which these email alerts are sent.

3.2 Personalized interface

The International Children’s Digital Library and the Perseus Digital Library allow registered users to configure their interface. Users can choose their preferred search interface and preferred language.

3.3 Search or action history storage and display

The New York Public Library Digital Gallery can store up to 50 search queries in a current session for users to choose from later. ScienceDirect can store all the major actions a registered user does including home pages visited recently, recent quick searches, and full articles viewed.

3.4 Personalized links

Five digital libraries allow registered users to set up their quick links in the system. These links can be pages with the digital library or other sites on the Web.

3.5 Personal bibliography and Peer-to-peer facility or recommendation

The ACM Digital Library (http://portal.acm.org/dl.cfm) allows users to create a "virtual binder", which is the user's personal bibliography retrieved from the collections of citations in ACM's
graphic databases, the Digital Library, and Guide to Computing Literature. It also identifies papers which at least 500 readers of a particular retrieved paper have read to the users as a recommendation list.

Apparently, personalization services provided by existing digital libraries are mainly user-driven and do not require complicated computing algorithms to support them. More personalization services are expected to be added. For example, the International Children’s Digital Library (http://www.icdlbooks.org/) plans to allow users to personalize their research results, save favorite books on a bookshelf, and return to the last page they were reading.

4 Social Computing Services in Digital Libraries

The author then examined the websites of the 29 digital libraries to identify the following social computing tools: online chats, discussion forums, blogs, wikis, and web feeds. It was observed that almost all of the digital libraries provide search and browsing functions. Many of them also contain a Help component on the websites. The Help Web page may present a FAQ list, search tips, and/or an email or HTML form to allow users to contact the digital library staff for questions. (This current study does not include an analysis of those functions.)

Table 4 presents the operational definition of each social computing tool and the frequency of providing the service. Among the 29 digital libraries, about 45% (13) provide at least one of the five social computing tools. Below is a brief explanation of the results.

<table>
<thead>
<tr>
<th>Social Computing Tool</th>
<th>Operational Definition</th>
<th>Frequency Libraries</th>
<th>IDs of the Digital Libraries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online Chats</td>
<td>Real-time online communication between DL staff and the user(s).</td>
<td>2</td>
<td>7, 16</td>
</tr>
<tr>
<td>Forums</td>
<td>A “place” on a website where the users or the staff can post public messages or comment on others’ messages.</td>
<td>3</td>
<td>2, 11, 27</td>
</tr>
<tr>
<td>Blogs</td>
<td>A “place” on a website where the users or the staff publish in journal style; it is displayed in reverse chronological order, it also allows comments for the published entry.</td>
<td>3</td>
<td>12, 14, 27</td>
</tr>
<tr>
<td>Wikis</td>
<td>Similar to blogs, but allow the users to edit the available content that they may or may not originally have written.</td>
<td>1</td>
<td>25</td>
</tr>
<tr>
<td>Web feeds</td>
<td>A technology of delivering frequently updated content, which allows subscribed users to read with a web feed reader.</td>
<td>7</td>
<td>1, 5, 9, 10, 12, 25, 29</td>
</tr>
</tbody>
</table>

- Online Chats: Digital Commons@Columbia and The Ameriis convenient because no extra implementation effort is needed in order to provide the service. However, the downside of the design is that the reference librarians who are conducting the online chat need to become familiar with the collections in the digital libraries in order to help the users.
- Forums: Forums are convenient tools for exchanging information and have been used extensively in online learning environments. In digital library settings, they can be used for the staff and users to post useful information and to comment on others’ postings. Among the discussion forums provided by the three digital libraries, the one on BiodefenseEducation.org (http://www.biodefenseeducation.org/) did not seem very active. Only the staff had posted messages to it; no comments had been allowed to be posted during the period of this analysis due to “Comment spam”. The Historical Voices Educator’s Forum (http://www.historicalvoices.org/education.php) was also at a very early stage. The digital library plans to provide educators the opportunity to comment on lessons posted at the Historical Voices Educator’s Forum. The forum for the bookmobile at the Internet Archive (http://www.archive.org) is much more established. One can find active discussions on the bookmobile events.
- Wikis: A wiki is implemented at the Alexandria Digital Library (http://clients.alexandria.ucsb.edu/webclient/index.jsp). It is called “Confluence” and its purpose is to facilitate information sharing among the users. All content in Confluence is organized into spaces. One can simply click on one of the spaces to start browsing the content. Confluence is actively used. There are 6 spaces: ADL Gazetteer, ADL Library Software Documentation, ADL Library Software FAQ, ADL News, HOW-TO's, Library Support Portal, and Pegasus. Many topics could be found under each space.
- Web feeds: With the help of web feed technologies such as RSS, digital libraries can “push” their contents and services to their users rather than waiting for them to visit the website. Seven of the digital libraries have RSS feed on their websites. One can find a RSS feed icon with text on their web sites.
5 Discussion

The analysis of the 29 sample digital libraries demonstrates that personalized services and social computing tools have been adapted by a few digital libraries, although the types of services are limited. Some digital libraries have gone further than others. A good example of personalized services can be found at the ACM Digital Library (http://portal.acm.org/dl.cfm). This system has a separate page describing its personalized services including Binders, Peer-to-Peer Facility, Links, and Table-of-Content Alerts. These personalized services are only available to ACM members. The International Children’s Digital Library also makes an effort to serve its users all over the world. Currently, registered users can choose their preferred search interface and language. Kids can also "choose a monster to guard their password". In the future, the system claims that the users will be able to personalize their search results, save favorite books on a bookshelf, and return to the last page they were reading.

The author believes that personalized services are much needed for digital libraries as the volume of the collections grows and the users are challenged by information overflow. Currently many digital libraries provide a browsing function which allows users to browse the digital object in the system, but if a digital library becomes too large, the browsing function would become less useful without personalization. Personalized services have the potential to save user time and effort in finding relevant information.

As for social computing services, the Internet Archive implements a Web archiving blog and a Bookmobile forum. Both of the services have been well utilized. The users employ those "places" to share their joys of the bookmobile events and exchange information on important issues. The services add great value to the digital library.

Social computing has great potential to be integrated as services into various digital libraries or repositories. The benefits of integration are that they can:

- Make a digital library a 'place' for users, developers, and librarians to get to know each other and understand each others’ perspectives regarding digital objects in the system. Social computing forms such as forum and online chats can provide convenient conversational tools for different players in digital libraries;
- Provide an educational facility for users to learn the system. Users can learn about the digital library more effectively through talking with other users and the designer/administrator of the digital library system;
- Allow users to help themselves to find answers to their questions;
- Facilitate the digital library researcher’s efforts to study user behavior in digital library settings. The logs/documents for all the conversations among different players can be excellent sources for user study;
- Involve users into the process of digital library (DL) design and maintenance to lower the cost of DL design and development. For example, for institutional repositories that need contributions from the community, it is possible to allow the users not only to upload their papers/works into the system, but also to 'tag' their papers or works as the first step of knowledge organization.

Should a digital library provide personalized services and social computing tools? The broad answer is yes. As described above, they will improve the general services of digital libraries. The more important questions then are which service or tool a digital library should implement, and how.

Desirable, matured, easy to use, and affordable services or tools are what a digital library needs. User needs assessment is always important when considering the addition of a new service or technology. To find out what the users want from the digital library and to implement gradually in a well-thought-out manner those services should satisfy the users' needs. Offering multiple tools to meet different interactions and collaboration needs should be considered. For examples, a forum would be good for users to ask questions and to get answers and a wiki would be useful for collaboratively building collections or creating documentation. A blog can be used to release related news and encourage comments/suggestions.

Digital library designers can choose different strategies to actually implement desired personalized services or social computing tools. They can choose to develop their own tools, to purchase commercial social software developed by companies, to apply open source systems, or to just 'borrow' the desired services from the Internet. As much of the social software is open source, and some websites provide social computing functions for free, integrating certain social computing tools can be very economical. For systems that do not want to install a social computing tool, another approach is very simple and affordable - borrowing services from the Internet. For example, Historical Voices has provided a link to Yahoo messenger on one page (http://ed-web2.educ.msu.edu/CEP817F03/Grant/links.htm), and encourages their users to chat with each other using Yahoo messenger.

6 Future Research

This study serves as the first step towards generally under
standing and improving digital library services. The analysis conducted here identified personalized services and social computing tools offered by current digital libraries, but to discover how the users feel about these services was beyond its scope. Well-designed user studies are needed to investigate the perceptions of digital library staff and users to personalized services and social computing tools.

The analysis also indicated that the majority of the digital libraries have not provided any personalized services or social computing tools. One possible reason is the immaturity of related technologies. For example, advanced personalization technologies such as automatic-user model generation are still at the experimental stage and need more exploration.

In summary, personalized services and applications of social computing tools are two promising strategies to improve the services of digital libraries. More research and investigation is needed to understand their effectiveness and appropriate use in digital libraries.

References:

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[Biographies] Jingqing Liu is a doctoral student in the PhD program of the School of Communication, Information and Library Studies (SCILS), Rutgers University. Her research interests include document recommendations, personalization in information retrieval, and digital libraries. She has presented and published in ACM SIGIR, ASIS&T conferences and proceedings.

Xiangmin Zhang is an assistant professor with the School of Communication, Information and Library Studies (SCILS), Rutgers University. His research interests include collaborative information retrieval, user modeling, human-computer interaction, and digital libraries. He frequently presents at international conferences and has published in Information Processing & Management, Information Research, Journal of the American Society for Information Science & Technology, Journal of Information Science, and Library & Archival Security, as well as ACM SIGIR, HICSS, ASIS&T, etc. conference proceedings.