Evaluation of Semantic and Social Technologies for Digital Libraries

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Abstract. Libraries are the tools we use to learn and to answer our questions. The quality of our work depends, among others, on the quality of the tools we use. Recently, the semantic web and social networking technologies are being introduced to the digital libraries domain. In this article we present the results of an evaluation of social and semantic end-user information discovery services for the digital libraries.

1 Introduction

Recent research and development in digital libraries domain focuses, among others, on using the Semantic Web [5, 12] and social networking technologies [4]. The results of this research made their way to projects like FEDORA [12], BRICKS [13], and JeromeDL [5]. Semantically-rich and carefully crafted metadata support expressive information discovery solutions. Social networking services can improve the overall usability of the information discovery and sharing; users become active producers of the metadata, hence a digital library can provide more focused and more accurate results through, e.g., recommendations techniques. So far the evaluation studies were conducted to show the value added of separate social and semantic components [6, 9, 10]. We believe that it is important to evaluate these solutions setup together for user experience in information discovery.

In this article we present results of the evaluation of the semantic and social information discovery features in the digital libraries. Our evaluation set up follows the results of the the comprehensive study reported by Fuhr *et al* [2]. We focus on the *usability* aspects of the user interaction with a system, which are measured through how the system is easy to learn, flexible, and adaptable to user preferences. Our evaluation measured three (*time to learn*, *rate of errors by users*, and *subjective satisfaction*) out of five metrics identified by Shneiderman and Plaisant [15]. We used the guidelines on preparing the Questionnaire for User Interface Satisfaction (QUIS) presented by Chin *et al* [1] to measure a subjective user satisfaction.

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Social and Semantic Information Discovery Solutions. During the evaluation users were allowed to use following semantic (first question-answering (QA) task), social (second QA task), and recommendation features (third QA task) implemented in JeromeDL [5].

Semantic features: *Natural Language Query Templates (NLQ)* provides expandable set of templates for complex natural language questions mapped to SPARQL queries [10]. *TagsTreeMaps (TTM)* [9] support filtering of the information space with a hierarchical tag cloud rendered using treemaps layout algorithm. *MultiBeeBrowse (MBB)* delivers faceted navigation using adaptive hypermedia techniques for exploring relations between information items [6]. *Exhibit* allows to filter information space, and render it with as a timeline or with the Google Maps [3]

Social features: *Bookmarks Sharing* allows users to maintain and share securely private bookshelf with hierarchical classification of bookmarks folders [4]. *Collaborative Browsing* facilitates collaborative sharing and reusing MBB queries [6]. *Blogging* component allows users to tag and to leave comments to resources [7]. *Resources Ranking* facilitate users in ranking resources.

Recommendation features: *Recommendations Based on the Resource Description* are computed using information about the library resource upon user request. *Recommendations Based on the Community Profile* are computed based on information in users profiles, including semantic annotations in the collaborative bookmarking component.

2 Evaluation Results

To compare results from participants using the classic and the semantic digital library we chose a popular, open source digital library – DSpace [14] and an open source semantic digital library – JeromeDL [11].

The core part of the evaluation consisted of three question-answering tasks; during each task, users where asked to answer one of seven questions from the domain of Internet psychology. They had limited time (*45 minutes*) to find the answer and supporting references in the digital library assigned to them. Each task that users were asked to complete was accompanied with a questionnaire measuring user satisfaction. There where two additional questionnaires: one before and one directly after completing the whole evaluation.

Both digital libraries contained **529** articles from `http://library.deri.ie/` and from `http://books.deri.ie/` and a set of **35** articles which provided correct answers to the aforementioned questions.

During the evaluation, **59 people** have registered to the evaluation apparatus; however, only **26 of them** completed it. Most of the participants where **21-25 years old postgraduates** or **under graduate students**; they major subject of education was **the informatics and the computer science**.

We have identified four questions, which we wanted to find answers for with this evaluation. The complete results have been published as a technical report [8].

Question 1: *Do the social and semantic services increase the quality of the answers provided by the users in response to given problems?* The answers provided by the DSpace users were of higher quality only during the first question-answering (QA) task; the quality of answers for the remaining two QA tasks and the average quality were slightly higher for JeromeDL.

Question 2: *Do the social and semantic services increase the accuracy of the references provided by the users to answer given questions?* The accuracy of references is a function of *precision*, *recall*, *fall-out*, and *f-measure* [8]. DSpace users were providing more accurate references during the first one or two tasks; however, the overall measures indicated higher accuracy for JeromeDL. The average *precision* measures were only slightly better for JeromeDL; the differences in the *recall* measures were much higher, even up to *58%* when compared to DSpace. Based on the aforementioned results, we can conclude that social and semantic services **do increase** the accuracy of the references provided to answer given questions.

Question 3: *Do the social and semantic services increase overall satisfaction of using the digital library?* To answer this question we have analyzed the satisfaction metrics for each stage of the evaluation, and additional ones gathered before and after the whole evaluation. The overall impression before and after using each system was much higher for JeromeDL. DSpace users were slightly more satisfied after the initial tasks. Also after the first question-answering task the overall user satisfaction was higher for DSpace ($|\Delta_t| = 37.87\%$). However, in later stages of the evaluation, the participants using JeromeDL were more than twice as satisfied as DSpace users. They rated information discovery features (up to 10 times) higher than DSpace users. Based on these results we can conclude that the social and semantic services do increase the overall satisfaction of using the digital library.

Question 4: *Which services, i.e., semantic, social, or recommendations, are found to be most useful by the end users?* The three features with highest satisfaction measures were resource-related recommendations ($\rho_s = 19.32$), collaborative bookmarking ($\rho_s = 17.76$), and bookmarks recommendations ($\rho_s = 15.83$). Among other features, all *social* were ranked higher than *semantic* ones. Hence we can answer that the type of features the users found most useful were the *recommendations*, followed by the *social/collaborative* solutions.

3 Conclusions

Results gathered during this evaluation show the advantage the enhanced information discovery features can offer to digital libraries. Not only users' satisfaction is higher than when using non-semantic digital library; also the quality of the knowledge they gather and use is of higher quality.

The users are more eager to depend results of their search process on the automated solutions, such as recommendations, and on their trust in the information provided by their friends. Therefore, the meaning of semantics in the digital libraries should heavily include the social semantics. Future research on

semantic features should concentrate more on improving accuracy of automated recommendations services and usability of existing solutions.

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