Exploring Gadget-based Interfaces for the Social Semantic Desktop

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Abstract—A large number of tools has recently emerged supporting information management for individuals in their social context. Semantic technologies play an important role in the development of such tools because they allow for advanced organisation, annotation, navigation and search capabilities. In this paper we present SPONGE (Social and Personal Ontology-based Gadgets), a set of gadgets for representing and accessing information in the personal and social space of knowledge workers via cross-media and cross-application linking and browsing of information resources based on semantic web data structures, coupled with automated metadata generation support. In SPONGE, we aim to provide a richer, faster, and potentially lighter-touch way to build personal and social knowledge spaces than current desktop applications allow. Moreover, provisions are made to support ad-hoc collaboration between individuals and to enable seamless access to personal and shared resources.

Index Terms—software, knowledge representation, collaborative work, graphical user interfaces

I. INTRODUCTION

In recent years, the number of ways to keep and manage personal information has increased considerably, in line with the overall increase in the number of devices, technologies and applications on which knowledge workers rely. The attendant fragmentation of personal information increases the probability of keeping something locked away in a device, application or format and forgetting that something was ever seen, heard, or read in the first place [15]. Information does not only exist in personal spaces, but is continuously produced and revised in knowledge networks [12]. Knowledge networks are social networks, which are assembled in order to create, revise and transfer knowledge, for the purpose of creating value [23]. Due to the increased availability of data and evolved standards in the last years, applications of semantic technologies in organisational information systems have increased [14]. The application of ontologies in organisational information systems allows the integration of heterogeneous information items within the organisational memory [3, 16]. Semantic architectures bring together information sources, which, previously, would have been more difficult [3]. Recently, we have noticed the propagation of semantic technologies in tools supporting information management for individuals in their social context [4, 14]. Still, such tools require an additional layer of information processing which poses challenges to everyday use of such tools by knowledge workers.

In this paper we present SPONGE (Social and Personal Ontology-based Gadgets), a collection of gadgets that aim at a readily usable utilisation of semantic technologies for supporting personal information management and ad-hoc collaboration within knowledge networks. We first discuss related work and our research motivation and objectives. Next, we outline our research methodology. We then present the system functionalities for annotating, storing, accessing and sharing metadata of information resources and its architecture. We conclude with an analysis of evaluation results focusing on usability and perceived benefits for knowledge workers; we draw conclusions and outline areas of further work.

II. RELATED WORK, RESEARCH MOTIVATION AND OBJECTIVES

To support individuals better manage their personal information, a wide variety of tools using metadata have emerged. Such examples are GNOME-PIM, Gnowsis [22], Haystack [19], IRIS Semantic Desktop [6], KDE Kontact, MyLifeBits, Bento, etc. Metadata are used to characterise information; as such they provide means to organize information and make it possible for machines to automatically process and interpret information. Metadata aim to address information fragmentation and tackle information heterogeneities.

To support information management and sharing in a social context, several collaborative tools have been developed, such as on-line social spaces and wikis. While a number of popular wiki tools are available, such as MediaWiki, TWiki, Deki Wiki, XWiki and JSPWiki, some of them are built in order to utilise metadata and semantics such as Semantic MediaWiki, OntoWiki and IkeWiki. However, learning to apply metadata, both in personal and in social context, is time-consuming and consistently using them in different tools is burdensome, therefore they can add complexity to information management activities.

Our motivation in this paper is to develop an easy-to-use ontology-based tool for personal information management and ad-hoc collaboration within knowledge networks, which helps typical knowledge workers to overcome some of the above mentioned problems. We embark on a recent research direction related to the emergence of the Social Semantic Desktop (SSD), an open source software framework supporting the management of all relevant information in the
personal and social space of knowledge workers via cross-media and cross-application linking and browsing of information resources based on standard semantic web data structures coupled to automated metadata generation support [8, 21]. In SPONGE, we aim to provide a richer, faster, and potentially lighter-touch way to build personal knowledge spaces than current desktop applications allow. Moreover, provisions are made to support ad-hoc collaboration with colleagues and to enable seamless access to personal and shared resources.

III. RESEARCH METHODOLOGY

Our work focuses on professional business services firms, i.e. firms that provide business services which are based on the application of highly specialized knowledge and expertise [7]. Examples of such firms are investment banks, law and consulting firms. Being knowledge intensive organisations, business services firms employ professionals that can be characterized as typical examples of knowledge workers. Case study for our research was TMI1, an international management consultancy, which is a typical professional business services firm.

In order to understand user needs and requirements, we conducted user research at TMI using ethnographic methods such as contextual observations and interviews. From our study we extracted requirements about typical processes and we used personas [2, 11] as a means to encapsulate user needs. Personas are based on the knowledge of real users and therefore identify users’ behaviour patterns, motivation, expectations, goals, skills, attitudes and environment. Using these typical processes and personas we developed a number of use cases representing the information creation and sharing work processes within TMI. Based on the use cases, we iteratively developed prototypes which we repeatedly evaluated in small groups of TMI employees. This software engineering process allowed the development of the SPONGE architecture by working backwards from the desired functionalities and requirements, while simultaneously refining the prototypes and taking into account user feedback.

We used two methods to evaluate SPONGE: The unobtrusive observation method using the “think aloud” protocol was applied in which end users continuously think out loud while using the system, expressing their understanding of the system features, difficulties encountered, preferred features, expectations, etc. Moreover, we collected feedback on the system quality & use and perceived benefits using a questionnaire that was distributed to the test users at the end of the evaluation sessions. In order to define and validate the questionnaire, we first developed an initial model and questionnaire based on prior research on information systems evaluation (e.g., information system success [20, 9], user satisfaction with knowledge management systems [17, 24], user perceived web quality [1], end user computing satisfaction and user performance [10], web system quality [5]). We then evaluated the initial model using Principal Components Analysis, a commonly used statistical analysis method (see e.g. [20, 18, 10, 1]). Following the statistical analysis, a refined model and corresponding questionnaire was developed which was used by test users to evaluate SPONGE, as discussed in section 5.

IV. SYSTEM DESCRIPTION

A. Overview and interfaces design approach

The design and development of SPONGE was based on three principles. First, both usability and friendliness of the graphical user interface were deemed highly important. Second, it is important that different levels of users’ familiarity with SSD functionalities and ontologies are supported. Users who are apt to try advanced features e.g., for customising the ontology, they can use PSEW2, the desktop application provided by the SSD. Other users may prefer the simplicity of the SPONGE interfaces even though not being able to readily use the full set of available SSD functionalities. Third, for the development of the user interfaces we exploited physical desktop interaction patterns with which users are familiar. For instance, we introduced the concept of SPONGE Notes, a digital metaphor for sticky notes, where the addition of an RDF triple is represented by the addition of a yellow note on an existing resource. There are two parts in a SPONGE Note: the top underlined part is the predicate while the bottom one is the object. Thus the RDF triple $S – P – O$ (Subject – Predicate – Object) is represented as the S being the desktop resource and the SPONGE Note on it containing P and O.

The concept of gadgets was selected as the main user interaction approach. A desktop gadget is a small footprint application, which resides on the user’s desktop using little desktop space and limited computer resources. Its purpose is to provide information management functionality to the user in a non-intrusive manner and using as few resources as possible.

However gadgets have limited available desktop space and eventually can present a limited amount of information. A solution to this limitation is to combine gadgets with the web browser in order to present dynamic web pages containing the required additional information. SPONGE is designed as a combination of small gadgets and dynamically generated pages accessible from the Web browser.

B. System walkthrough

SPONGE provides support for three areas of user activity: searching for information, characterizing information by means of annotation with keywords and collaborating with colleagues.

The Search gadget provides an interface for locating resources, not only in the local desktop, but also in shared workspaces and in other colleagues’ computers. The Search gadget consists of a query text box. The results appear in a Web page, which pops up immediately after the user types her/his query in the Search gadget (Figure 2). Annotations of each information resource are presented next to the resource that they relate to, arranged in a table of SPONGE Notes.

1 http://www.tmiworld.com

2 http://nepomuk-eclipse.semanticdesktop.org/xwiki/bin/view/Main/PSEW
Results are organised in categories which appear on the top of the results page. On a first level results are organised by location. My Desktop category returns the resources locally stored in the desktop. Workspaces retrieve results from the system’s shared collaborative spaces where the user is a member. Peers category contains the resources located in other users’ desktops, where the P-grid and Gridvine infrastructure of the SSD is utilised [13]. The local resources and classes, presented under My Desktop are categorised into their specific types - Documents, People, Topics and Tasks. Retrieved results include information resources containing both terms that match exactly the query terms and semantically similar terms. Similarity is derived from ontological proximity of terms. For example, consider a user who searches for information related to the automotive industry. Although no exact matches are found, search is going to retrieve a local document and contact details of a person, both having some relation to the automotive industry. It will also return documents from other users’ desktops and articles written in workspaces.

Figure 1. The Search and SPONGE Notes Gadgets
The SPONGE Notes gadget is used to present and add annotations to desktop resources which are translated in RDF triples. This gadget allows users to drop a resource on it (e.g., a file). At the first drop the resource is scanned for metadata, such as the name and the author of the resource, and a new instance of a suitable class in the underlying ontology is created. The metadata are displayed in sticky yellow notes (Figure 2), following the visual metaphor of sticky notes. To add a SPONGE Note, the user clicks on an icon with a "pile" of SPONGE Notes. Clicking on the pile brings up a dialog box with all possible relations and objects for annotating this resource. As soon as the user chooses or types a relation (auto-complete is supported), the list of objects is refreshed to allow only valid annotations to be applied.

The SPONGE Notes gadget displays buttons for sharing the resource in the peer network and for ontology editing (by clicking on the wrench icon). Another capability of the gadget is the suggestion of annotations to the user by utilizing SSD components which provide recommendations based on an analysis of the ontology structure, of the social context of the user and of the text of the resource in conjunction with public metadata repositories such as DBpedia1. Recommendations are presented as SPONGE Notes with a distinct magenta colour and labelled with the keyword “Suggestion” (Figure 1). The users can either accept or reject a system recommendation. The acceptance adds the corresponding SPONGE Note (coloured yellow) while rejection removes the suggested note.

Figure 2. Search Results
Collaboration between users is supported by SPONGE workspaces. The idea behind workspaces is to provide a placeholder for storing, organising and sharing resources needed for the accomplishment of personal and collaborative tasks and to organise work-related tasks. Workspaces can support either the personal work of individual users or the collaborative work of groups. Each workspace consists of one or more wiki pages placed in a hierarchical structure. Any user can create a workspace and invite members to participate. Any workspace member can browse workspace pages, create new pages, edit page using typical wiki functionality and communicate in workspace forums and chats.

Figure 3. Adding a new SPONGE Note in a Workspace Page
SPONGE Workspaces provide semantic annotation facilities using SPONGE Notes (Figure 3). Notes can be attached to every page to capture semantic annotations with the same look and feel as when annotating desktop information resources.

C. Technical architecture
SPONGE is developed in a two-part architecture comprising the local and the workspace part. The local architecture

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1 http://dbpedia.org
components create the gadgets and the web environment that handles dynamic creation of web pages.

SPONGE gadgets are developed in Microsoft .NET Framework. Gadgets, developed as small windows applications, have different appearance from typical windows applications: they are transparent at the edge and without titles. They aim at efficient use of the limited available screen space. The local web environment is provided by a servlet application following the Java Enterprise Edition EE technologies, where jetty server is used for deployment and Ajax for the presentation of search results and for annotation. Asynchronous calls keep the application responsive when massive time-consuming access to local and remote RDF stores is required. These calls also allow the use of intuitive interfaces, while they also enable the loading of only applicable predicates and objects. Moreover, SPONGE utilises the Dojo JavaScript framework to create the SPONGE Note, the dialogs and for performing XML calls when loading suggested objects.

**Figure 4. Overview of SPONGE**

The SPONGE Workspaces architecture extends IkeWiki [25]. IkeWiki is an open source semantic wiki offering RDF support for storing formal knowledge. Our extensions include an improved interactive user interface in order to support collaboration in workspaces, a role management system allowing restricted access to the workspaces and, using SPONGE Notes, easy semantic annotation of pages. Figure 4 displays an integrated overview of the technical architecture of SPONGE and its inter-relation with SSD and IkeWiki. The communication between the local SPONGE services and SSD components utilises the OSGi framework. The SPONGE gadget engine stands on top of the services that are built into the bundles. Local SPONGE services connect to the remote workspace server using remote XML and JSON calls to the server. These requests are hidden to the presentation layer, allowing for possible extensions of the system and providing a unified user interface to the end user.

V. EVALUATION

SPONGE has been evaluated by 11 employees from offices of TMI in Bonn and Athens, the professional business services firm that was used as a case study in our research. In each office, employees from all business areas were invited to the evaluation: trainers, managers, directors, trainees, designers, analysts, etc. SPONGE was configured with a TMI-specific ontology which users could extend. Users were asked to test SPONGE by following predefined scenarios with no prior tutorial or demo. The scenarios consisted of realistic work related tasks that should be accomplished with SPONGE in combinations with existing tools such as mail and office applications.

The usability testing focused on three areas: interface and visual cues, learnability and help, and integration between the components and the desktop environment. In terms of interfaces design, the Search gadget was assessed as intuitive and easy to use. The one-step search interface was positively evaluated as well as the fact that it is easily accessible. Search result presentation was perceived meaningful. SPONGE uses different visual representations for different types of documents. This feature was considered useful, however the specific symbolic language used was not universally accepted; some users expressed difficulties in identifying the identity of some resources. Another issue which emerged during the usability testing is the fact that the different SPONGE notes appeared in the exact same way and format, i.e., there is no visual differentiation between topics, tags, etc.

SPONGE learnability was positively evaluated. During usability testing, all users could easily use SPONGE without prior training. Users could browse through gadgets and intuitively understand their functionalities. Nevertheless the sense of user orientation can be improved by more appropriate labelling of retrieved resources, categories, system menus, etc.

Users interacting with SPONGE expected to use a unified environment, which could help them find, edit and annotate documents, share knowledge and create workspaces. They appreciated the easy transition between the different SPONGE components (Search, Notes, Workspaces) but they would prefer even better integration between them (e.g., ability to upload a document onto a workspace by right-clicking on the resource from the search results page).

The analysis of the questionnaire response revealed that the majority of test users (81.8%) perceived that the speed of interacting with SPONGE and the speed of building knowledge spaces was high and that it was easy to switch between different functions, e.g., moving from searching to browsing information. 63.6% of test users perceived SPONGE as offering rich information about their resources by means of recommended annotations, crawled metadata, etc.; their opinion concerning the availability of information available in SPONGE was nevertheless neutral. One reason for this may be that fact that only a limited number of information resources from the corporate intranet only have been crawled by SPONGE prior to the tests. Moreover, some users (54.5%) did not find all system outputs straightforward which reflects the need for improvements in system labelling, as identified also in the usability tests. Perceived benefits when working at a personal level were the abilities to create rich information about desktop resources (100% of test users), to flexibly organise their resources (100% of test users), to search and retrieve resources (100% of test users), to edit and change resources (90.9% of test users) and to create new resources (81.8% of test users). Perceived benefits when working at a group level were the abilities to search and retrieve resources created by others (100% of test users), to collaboratively create new information (90.1% of test users), to share know-how and experiences (100% of test users), to express and
develop ideas in teams (81.8% of test users), to improve quality in management of shared resources (81.8%) and to provide comments and feedback to groups (45.5% of test users).

VI. CONCLUSIONS

In this paper we presented SPONGE, a set of gadgets for representing and accessing information in the personal and social space of knowledge workers based on standard semantic web data structures and semantics-based services such as metadata recommenders provided by the Social Semantic Desktop. In developing SPONGE, we followed a rapid prototyping approach coupled with user-centred research methods. Our research revealed a number of important usability issues in ontology-based systems, such as the appropriateness of the terminology used, the degree of integration with desktop activities and the clarity of choices and features offered to the users that exploit the underlying semantic information.

Our research provides some evidence about the usability and perceived benefits of the light-touch interfaces for the social semantic desktop in professional business services, a highly representative domain of knowledge work. It helped us understand the usefulness and limitations of applying semantic technologies and concepts in everyday tasks of knowledge workers. It revealed tradeoffs for users of working and collaborating with more structured information. Issues such as performance, reliability and scalability are often considered challenging for enterprise semantic information systems. This case study showed that pragmatics, such as usability, interface design, and terminology used also play a significant role in the design of ontology-based systems addressing end users and should not be underestimated. Our work sheds some light on designing interfaces to support the production, publishing, annotation and sharing of information resources in a personal and social space and proposes a software system for enabling knowledge workers build personal and social knowledge spaces.

REFERENCES