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SMARTBOOK: SEMANTICS INSIDE

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Abstract. This paper presents a vision for the future of the e-books which entails further development of technologies that will facilitate the creation and use of a new generation of 'smart' books: e-books that are evolving, highly interactive, customisable, adaptable, intelligent, and furnished with a rich set of collaborative authoring and reading support services. The proposed set of tools will be integrated into an intelligent framework for collaborative book authoring and experiencing called *SmartBook*. The paper promotes the idea that the semantic technologies, intensively developed recently in connection with the Semantic Web initiative, can be incorporated in the book and become the key factor of making it 'smarter'.

1. Introduction. The information technologies available today have made possible the advent of the e-book that overcomes a number of the weaknesses of the classic scroll described so well by Socrates 24 centuries ago. Most of the numerous recent e-book projects, such as the Gutenberg Project[1] and

ACM Computing Classification System (1998): H.3.3, I.2.4.
Key words: E-book, Information Search and Filtering, Personalization, Topic Maps, Semantic Web.

[1] `http://www.gutenberg.org`

Google's Books project[2], focus on digitizing paper books and hosting them in online repositories. However, current technologies allow creating multi-modal, interactive, customizable, mobile and social content, which provides an enormous potential for extending the fundamental concept of the book and its impact on readers. Similarly to the increasingly popular social web sites, a novel e-publishing platform can allow e-book authors to publish drafts of their books so as to get early feedback. This will transform book writing into a form of collective brainstorming and will result in 'live' books and a shorter writing cycle. Such e-books could be continuously updated and refined by many stakeholders; for example, readers could discuss published online content with the author or publishers could recommend extensions with information in demand.

Current advancements in related areas allow building tools not only for authoring interactive multimedia content, but also for enhancing readers' book experience beyond simple reading, for example, with possibilities for *in-book search, browsing, skimming, visualisation, summarisation, non-linear reading, taking notes, sharing comments, etc.* Although software tools supporting some of these functionalities individually are already available, *there is a need for an integrated environment* that provides a complete set of social and intelligent tools to facilitate book writing and reading.

The SmartBook project[3] aims to develop an intelligent, community-centred framework for authoring and experiencing of a new generation of 'smart' books – e-books that are evolving, highly interactive, customisable, adaptable, intelligent, and furnished with a rich set of collaborative authoring and reading support services.

2. Related Work. E-books originate from early efforts for complimentary publishing of existing texts online, such as the Gutenberg Project followed by the early digital text publishers such as Hard Shell Word Factory[4] and Online Originals[5]. These texts are typically linear; popular formats include plain text, HTML, PDF, Word, Open Standards such as IDPF[6], or proprietary formats such as Kindle's AZW[7] or Mobipocket's PRC[8]. Although most e-books can be read on a standard PC, a number of specialized devices have emerged, such as Sony

[2] `http://books.google.com`
[3] Funded by the Bulgarian NSF
[4] `http://www.hardshell.com`
[5] `http://www.onlineoriginals.com`
[6] International Digital Publishing Forum (formerly Open eBook Forum)
[7] Amazon Whispernet
[8] PRC is a format for code databases in Palm OS, used by the Mobipocket e-book-reader.

LIBRIé (2004), Sony Reader (2006), and Amazon Kindle (2007), that take advantage of better book-like form factors and new display technologies that are easy on the eye (known as e-paper or digital paper).

The new generation of Web 2.0 systems (including blogs, wikis, personal journalism and sharing sites) is changing the general attitude to public writing, sharing and artistic collaboration [17]. This new Web literacy is changing people's expectations of digital media and challenges the existing notion of authorship, making it the right time to explore how community-driven writing and reading could be applied to formally published materials. The existing work in this area includes Amazon's open publishing system, called Digital Text Platform[9], which allows authors to self-publish to their Kindle platform, and Hypertext publishers, such as Eastgate Systems Inc.[10], which offer self-contained hypertexts that have many of the combined properties of open hypertexts and e-books. The latter, although formally authored, multimedia and non-linear, include no annotation or community aspects.

Recent research and development efforts in digital content authoring have concentrated on authoring educational hypermedia, focusing on system adaptivity [5]. The resulting hyper-books are interactive, rich in terms of employed modalities for content presentation, and easily browsable. However, their structure (hyperlinks connecting selected concepts to Web pages explaining them) departs significantly from the traditional sequential textbook structure, which in many cases is more appropriate for story-telling or a narrative introduction of a new topic. Since readers are used to conventional printed media, hyper-books can often be more difficult to follow, as shown by studies reporting cognitive overload for readers [2, 14]

While technologies and tools for searching documents on the Web or in a digital library that best match a query have been the subject of tremendous interest and research in the last decade, the task of locating relevant information within documents has remained in the shadow. Recently, this task has become increasingly important as longer documents, including many e-books, have begun being published. Several approaches have been proposed for within-document retrieval, including passage retrieval [11] and content-based document browsing [10]. Harper et al. [9] proposed a tool called ProfileSkim that enables users to identify relevant passages of text within long documents by integrating passage retrieval and content-based document browsing.

Adaptive and recommender systems use user models aiming to help users

[9] `https://dtp.amazon.com`
[10] `http://www.eastgate.com`

in finding information, products, services, etc., that they are presumably interested in or prefer. There are two basic approaches pursued so far. Content-based filtering systems take into account individual preferences for certain object features and make recommendations on the base of the similarities between items (see for example [13, 15]). Collaborative filtering systems typically build on similarities between users with respect to the objects they are implicitly or explicitly interested in (e.g. [12]). There are also hybrid systems, which combine both approaches to avoid some of their limitations and improve the quality of their recommendations (e.g. [1, 4]).

3. The SmartBook Vision. Even today a significant amount of existing multimedia content is made available as a book companion (for example, on CDs, DVDs or on the Web). Digital facilities for book authoring and reviewing have influenced the workflows adopted by publishers and the processes followed by the involved individuals. Collaborative work that uses social network infrastructures as well as the fan art and fan fiction that often accompany books on the Web are significant developments in both online authoring and reading. The way in which we experience books has therefore changed dramatically. Books can be experienced in print, on the Web or on portable devices and they can be discussed in forums, enhanced by fans and be part of a shared experience among creative communities.

We advocate that it is time to re-conceptualize the traditional notion of a book by examining and extending the essence of what the book means to individuals and to the society and culture at large, and how this could be supported by digital platforms, connectivity and the emerging digital literacy. We believe that *the new generation of e-books should better support creative communities, foster talent and promote innovation.* This entails further developing of technologies that will facilitate the creation and use of *the new generation of 'smart' e-books that are evolving, interactive, customisable, adaptable, intelligent, and equipped with a rich set of author and reader support services.* We propose a set of tools that will be ultimately *integrated into an intelligent framework for collaborative book authoring and reading called* ***SmartBook***. The framework is envisaged to contain two main 'spaces': an author's space and a reader's space.

The *author's space* provides authors with personal and collaborative editing tools. A major difference between these tools and the wiki-based collaborative authoring tools (such as those in Wikibooks) is the ownership. Whereas the wiki approach allows any user to act as a co-author, SmartBook will preserve the traditional distinction of the roles of authors and readers; one or more authors –

the book's owner(s) – will be responsible for content creation. One of the main goals of SmartBook is to provide authors with a set of smart tools that facilitate the semantic annotation and exploration of the text (better and easier than it is currently possible) by employing emerging technologies and recent findings in the areas of Semantic Web, natural language processing, semi-automatic mark-up and text mining. The tools would make suggestions to the authors that they could tune and approve or reject.

In the SmartBook *reader's space* readers are able to create their own electronic copies of a book, in which they could mark, underline and comment, the same way they do in paper books. Readers are able to edit only their own copies; the original book content will be preserved. A reader could further share an annotated personal copy with other readers and the author(s). Semantic Web and personalization technologies will be used to provide efficient and context-aware search and browsing of the book content and reader's comments.

In addition, the framework provides users with *a virtual place where the involved stakeholders can discuss* subjects of common interest related to a book. For example, there are two default "meeting rooms" for each new book – one for writers and one for readers. Additional rooms could be created as needed. Writers' meeting rooms are restricted to agents involved in book creation, including writers, reviewers, and editors. The publisher is to set the access rights. Readers' rooms are open to and accessible by both the readers and the book's creators. The collaboration rooms will be furnished with state-of-the-art tools for sharing information and thoughts in written and oral form, such as a virtual white board, online video, voice conversation, etc. The aim is to bring together the most recent advances in technology in collaborative working environments in order to promote social contacts and facilitate interaction and knowledge exchange between readers, authors, and publishers. Thus SmartBook will be a promising candidate for becoming a key launch pad for growing and cultivating the emerging collective intelligence [16].

An interesting issue related to the new generation of e-books is how the role of the *publisher* will evolve. On the Web, anyone can publish anything. Quality control (e.g. peer reviewing) is not common, which makes content less trustworthy than scholarly publications. There are no selection guidelines for search engines. This situation makes the task of the readers searching relevant trustworthy information difficult, especially in the case of tight time constraints. This is even more important in educational scenarios, where the readers need trusted information presented in a suitable for learning way.

We see *personalisation* as one of the most essential features of a smart

book. In the proposed framework it is based on user modelling and recommender services implemented by employing semantic and data mining technologies. User profiles will be utilised in helping users to find content, resources and services of interest or preference. Personalisation applies to both user categories – authors and readers. It employs the above-mentioned approaches for recommendation – content-based and collaborative or social.

Figure 1 presents the overall architecture of the SmartBook framework. We discuss its components in the following sections. From a development perspective, the proposed framework is envisaged as an integration of tools developed by the project team with third party tools, such as multimedia editing tools and online communication facilities.

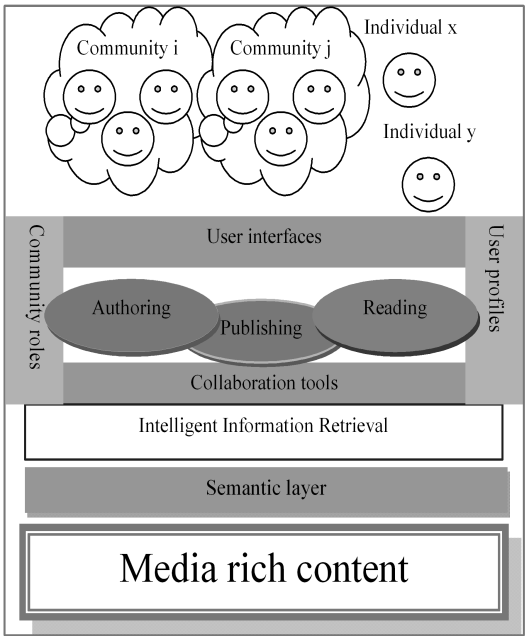

Fig. 1. SmartBook architecture

4. SmartBook Design and Development. Within the proposed general SmartBook framework we initially focus on the following aspects:

- Providing a collaborative rich media environment that facilitates the interaction between book stakeholders.
- Using Semantic Web technologies to present book semantics.

- Providing intelligent book services, including in-book search, browsing, summarisation, and recommendation.
- Personalisation of the book content and its presentation.

The keystones of the proposed framework are presented below.

4.1. Collaborative Multimedia Environment. The goal of the proposed collaborative environment is twofold. On the one hand it should enable rich media content authoring, and on the other, it should enable interaction between book stakeholders. Thus it integrates:

- a collaborative multimedia authoring space;
- a social book reading space.

From an authoring perspective, the collaborative authoring space enables state-of-the-art multimedia content authoring and management. It enables not only standard multimedia authoring but also frame-based timelines. In addition, it supports import of resources of various types, including text, image, audio, video, PDF, RTF, and HTML from files or the web, to be embedded in a page or stored in the author's resource space for future use. From a collaborative or community perspective, it supports 'live' feedback from readers about the book before and after its completion.

The reading space enables readers to read smart books in a browser and also to tag, annotate and bookmark. It is an interactive social space that allows user comments, annotations and tags sharing. In addition, it includes book discussion forums.

The collaborative environment implementation is based on Sophie 2 – open source software for collaboratively authoring and viewing rich media documents in a networked environment[11]. Sophie offers interfaces that are intuitive and easy to use by users without a technical background. Screenshots of Sophie interfaces are presented in Figure 2. The added functionalities are being implemented as plug-ins of Sophie.

4.2. SmartBook and Semantic Web Technologies. The World Wide Web changes significantly all aspects of our life. The most significant change concerns the way we store, present, search and access information. The web becomes the largest storage of information. The traditional libraries – the old treasure of information and knowledge – also have to change. The books, the core storage place of the knowledge for centuries, also are changing. First, the books became digital; after that multimedia was incorporated and then they became interactive. Now it is time to make them more intelligent. The first step in

[11] `http://www.sophieproject.org/`

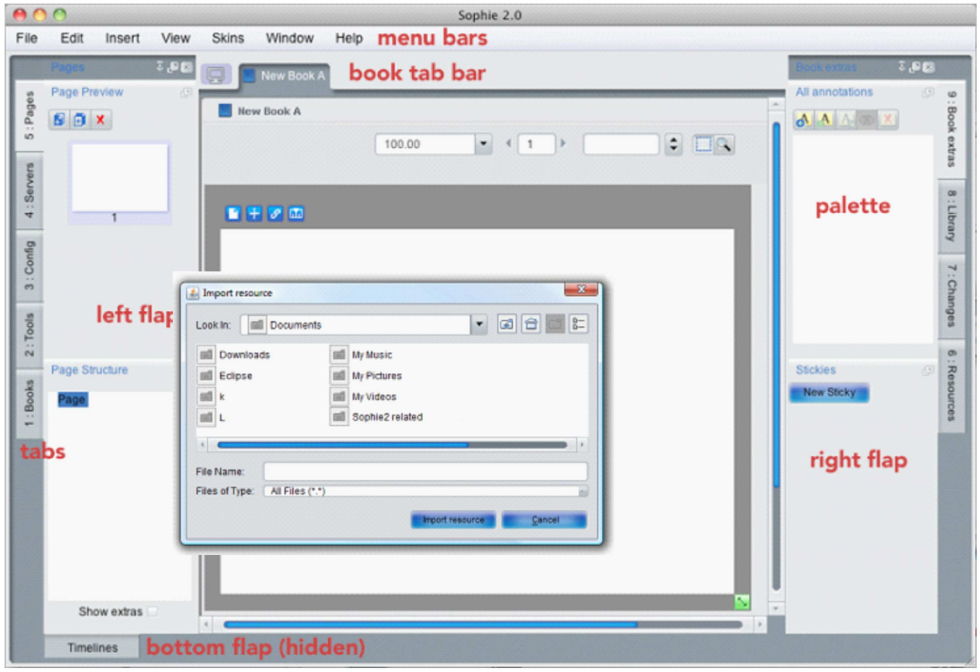

Fig. 2. Sophie 2.0 interface

that direction is to incorporate more semantics in them. If a book's content is semantically annotated, this would allow reasoning over it, which in turn could support more efficient semantic search, browsing, navigation, and personalization.

The Semantic Web technologies and standards provide the means necessary for the semantic annotation of documents. For prototyping purposes we have chosen to use the Semantic Web technology Topic Maps [15]. Topic Maps[12] (TM) are a knowledge representation technology typically used for defining a conceptual navigation layer that supports finding web resources of various kinds, such as documents, images, database records, audio/video clips, etc. We believe that the TM technology will provide a flexible and intuitive modelling paradigm for defining a conceptual navigation layer over the content of a book. The advantage of using the TM technology is twofold: on the one hand it provides a convenient and intuitive presentation of interrelated concepts embedded in the content, and on the other, they provide a standards-based format, which makes it interchangeable and interoperable.

[12] http://www.topicmaps.org/xtm

Basically, topic maps are collections of topics, associations, resources, and scopes. In the Topic Maps model the concepts are reified in topics, and they can be categorized using types. Topic Maps describe by means of topics what a resource is about. Associations express semantic relationships between topics, and the extent of validity of topics, associations, and resources is called scope. Topic Map associations typically interconnect topics in some kind of relevancy relations. It is much easier to discover information about a particular subject if you see it in the context of related information. Topic associations create 'lateral' relationships between subjects, allowing the user to see what other concepts are related to the subject of current interest and to easily browse to them.

By using knowledge standards, such as Topic Maps, it is possible to organize content in semantically rich data models. The expressive power of Topic Maps, commonly perceived as a method for indexing information resources, places the standard very close to Artificial Intelligence and knowledge modelling. Topic Maps resemble semantic networks and conceptual graphs but offer more – a unique, standards-based way of encoding and exchanging knowledge on the Web. Topic Maps provide an external meta-structure (a knowledge navigation layer) in form of a dynamic, semantically based hypertext.

Topic Maps can be viewed as a method for structuring and organizing information on the semantic and metadata level. They are appropriate for modelling content as they serve as a light-weight ontology model providing users with a browsable structure of the specific domain.

Our intuition is that Topic Maps (i) are expressive enough to present the semantics of the book content, and (ii) can support efficient semantic search and browsing. Thus we propose to express a book's semantics as a 'conceptual map' of the book content, and represent it as a topic map. This semantic layer over the authored content can be seen as a generalisation of the traditional 'back-of-the-book' indexes. Topic maps can also leverage the connection of book concepts to external ontologies and online resources.

In the next section we describe the proposed organization of the semantics of a smart book's content based on conceptual maps.

4.3. SmartBook Content Organization.

An innovative form of electronic book should combine the advantages of both conventional printed books and electronic hypermedia. To reach this goal, we propose two basic perspectives for organising content in SmartBook:

- A collection of hypermedia units modelling the traditional organisation of a book: sequential book pages containing the content structured in chapters, subchapters, sections, etc., using multiple modalities for presenting the

information (text, graphics, video, audio, etc.) This organisation is supplemented with functionalities that model traditional practices when reading conventional books, such as highlighting text, adding reader's notes, and book-marking.

- Conceptual classification: a *semantic structure* of interrelated concepts representing a knowledge structure of a subject domain or the interrelationships between the main subjects in the book (characters, events, places, times, etc.).

The second perspective can be seen as the above mentioned conceptual map.

With regard to content organization, SmartBook uses semantic models on three different levels:

- *Object level*: content objects annotated using metadata standards (such as Dublin Core) and expressed in popular multimedia formats. Such objects are interoperable and can be imported from other sources such as personal archives, or online repositories.
- *Book level*: a SmartBook ontology of book structure (referencing the object level) and further annotated with author and contribution information. This ontology will be open.
- *Conceptual level*: 'knowledge' maps modelling conceptually knowledge domains. This layer plays the role of a global schema, providing a declarative description of the subjects *within the content* in terms of key concepts and relationships between them. Knowledge maps are presented in standards-based formats (such as Topic Maps or SKOS[13]) and are therefore interoperable.

On a simple level, the latter will provide support for readers to easily search inside book content. However, since it is much richer in structure as compared with a simple index, it will provide much more to the reader – for example, such a structure can present concepts in the context of their relationships to other concepts. This in turn allows for efficient semantic search and browsing of the book content.

The proposed model of content organization would be especially appropriate and beneficial for presenting learning content. In an educational/learning context, the content objects (at the object level) can be additionally annotated using learning metadata standards, such as IEEE LOM[14].

The SmartBook semantic annotation module allows the user to build a

[13]Simple Knowledge Organization System, `http://www.w3.org/2004/02/skos/`
[14]IEEE Learning Object Metadata, `http://www.imsproject.org/metadata/`

'content map' while creating content in the author's space. Initially, the user chooses main categories that they would like to use to organize their content, e.g. characters, places, events, etc. Later, they can select a word or phrase in the text and insert/position it in the book's content map. When adding a term to the content map, the author will be able to define/name the relationship of that term to the term it is being connected to.

The created semantic structure is useful to both the author and the reader: to the author in creating the storyline and to the reader to semantically search/browse the content. In addition, it can be used as a base for additional automatic annotation – for example, for disambiguation.

The implementation of the semantic annotation module of SmartBook involves reusing some code of the topic map editor TM4L [8, 7]. The TM4L Editor[15] allows creating hierarchies of topics, topic types and instances, as well as relations among topics and between topics and digital resources. It supports TM-related operations such as merging, browsing, searching, and scoping. The content created by the Editor is compliant with the ISO XML Topic Maps (XTM) standard. Screenshots of the TM4L interface are presented in Figure 3.

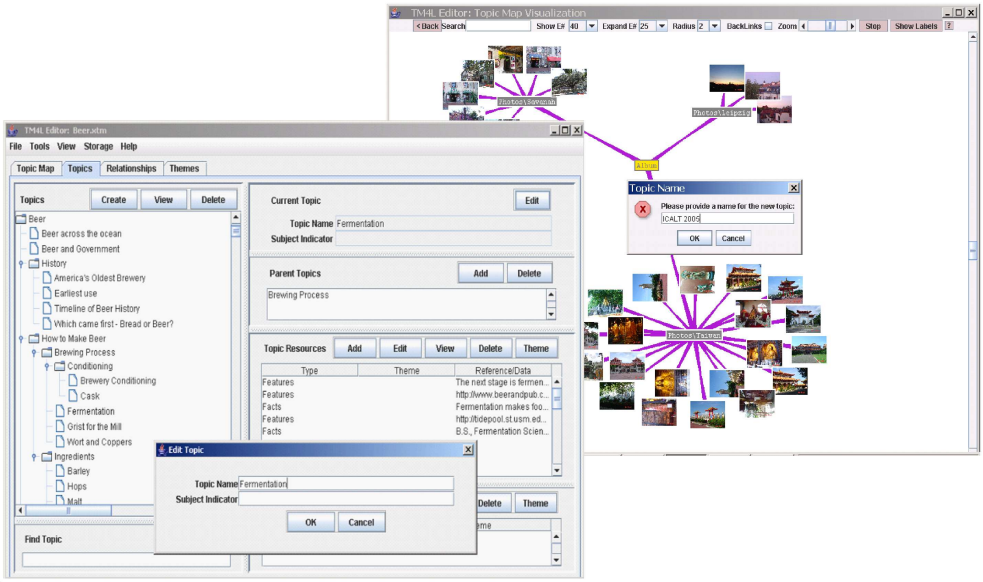

Fig. 3. Screenshots from the TM4L Editor: Textual and Visual Topic editing

4.4. SmartBook Services. We aim at developing a set of tools and

[15]TM4L Project, `http://www.wssu.edu/iis/NSDL/index.html`

services to help SmartBook authors and readers to efficiently perform their tasks. They are briefly summarized below.

- **Semi-automatic creation of content maps** of the authored content. An important objective of the project is to adapt and extend the semantic layering technology to meet the goals of SmartBook. To this end we will employ existing ontologies for finding resources on the Web relevant to the content of a given page/paragraph/selection, and allowing the user to connect them to the conceptual navigable layer on top of the actual content. A promising candidate software for integration for this purpose is the KIM platform[16], which provides a Knowledge Management infrastructure and services for automatic semantic annotation, indexing, and retrieval of documents. A prototype tool that integrates the KIM platform's services within the SmartSbook framework is under development.
- **In-book search.** Searching information within a book can be a very time-consuming job. Most of the book reading software provide only string search, which works well for text a few pages long. However, for free text search and navigation in the book content more powerful tools are needed. Experiments reported in [9] have proved that such tools can significantly shorten the time needed for accomplishing internal document-retrieval tasks, without losing the precision of the retrieved information. SmartBook will be equipped with in-book text-retrieval tools that efficiently support users trying to identify relevant information in books. The intention is also to employ the semantic layer to improve the quality of retrieved parts of the book.
- **Summarisation.** Readers often need to get a quick acquaintance with the book content, rather than reading it in detail. A brief summary of the content can save readers precious time. Human-generated summaries are expensive, but there are tools generating automatically summaries of the content. However, the general summary, which do not take into account a particular context and view point, are often not very useful. The SmartBook framework will provide the user with an ad hoc summary of the content by augmenting the books with tools for query-based summarisation. Furthermore, the captured user model will be employed to generate a summary that is personalised.
- **Visualisation.** Graphical representations of information and knowledge are proven to be very helpful for quick understanding of their essence. The SmartBook framework aims to provide the users with a rich set of visualiza-

[16] `http://www.ontotext.com/kim/index.html`

tion of the book-content map, in-book search results, integrated topic maps, ontologies etc. The visualized conceptual structure can be further used for content navigation and exploration, with an intuitive user interface.

- **Context-aware 'live' search and recommendations of relevant resources**. Finding relevant resources and supplemental information that support the process of text creation is a time-consuming and often distracting job for the author. With the increase of digitally stored information, accessing diverse information resources is easier, but at the same time it gets harder and harder to find relevant information that gives you a good view on the subject you write or read about. We developed a prototype of an autonomous, just-in-time-information-retrieval agent [6], which captures the authoring context, then finds and recommends relevant accessible resources in an non-disturbing way (see Figure 4). Having the process of gathering relevant information automated greatly improves the user's productivity and saves her/his time.
- **User-Modelling Services**. A core component of the SmartBook framework is a user-modelling server that provides services for user models' acquisition from log files and their use for personalisation of the framework's services. The personalisation services will support both basic types of recommendations: *content-based* – based on the similarity between items and *collaborative* – based on the similarities between users. Further, it will combine the evidences from the above pure types to get a synergetic effect and improve the quality of recommendations. The framework environment will be able to retrieve information for the user model and adapt the workflow to the customised model. Authors and readers will be able to inspect their constructed user models. This way the user will be provided with a personalised interaction style and content.

Conclusion. The SmartBook vision implies re-conceptualisation of the notion of a book as rich-media, interactive, and intelligent content serving as a focus point for community discussions. It employs technologies that facilitate the creation and use of a new generation of published smart books. Although research and educational scenarios clearly demonstrate the need for more formal notions of publishing of digital texts, the ideas are general in nature and transferable to other book genres.

SmartBook is envisaged to impact four key areas that are highly relevant: participative and communicative forms or content; publishing of innovative content; automated collection and distribution of knowledge; automated links be-

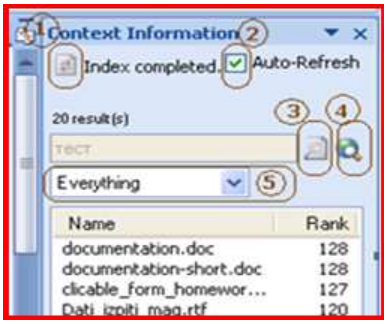

Fig. 4. Screenshot from the context-aware 'live' search agent's user interface: 1. Indexing button. 2. Change behaviour button. 3. Search the Desktop button. 4. Search the Web button. 5. Filters list

tween scientific data and discussions. It will have a significant impact on the first three of these areas and will indirectly make contributions to the fourth. With regard to the last one, SmartBook is not focused on the e-Science domain in particular, but can efficiently support general writing and discussion and publishing workflows, rather than those more tightly associated with experimentation and sharing of results.

SmartBook is advocating a revolution in the way digital material is published trough enabling evolutionary creation of text over many iterations. It also employs community-centred and personalisation techniques that could be extremely useful in the dissemination of scientific results – either for scholarly discussion in professional communities or to aid the discourse and relationship between experts and the general public.

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