Information Delivery for the End User of the Semantic Web

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Abstract. We propose the information delivery process for the end user of the Semantic Web, which was divided into three main steps: Collection, integration and aggregation step, Filtering or querying step and Presentation step. Contemporary search engines are our starting point. We analyze them from the users' point of view: how they support users, and which user requirements they try to approach. We also develop a scenario to show how the Semantic Web may solve the problems analyzed. Further we focus on presentation and interfaces for information delivery, since it affects the most overall users' experience in search for the relevant information.

1 Introduction

Information overflow was identified as a problem a long ago: the terms *electronic junk* [1], *information overload* [2] exist for more than 20 years. A large amount of the development in information systems is devoted to delivering to the final user an appropriate amount of information. This is particularly important for the Web where the information is abundant. Many techniques have been developed within information retrieval and filtering [3]. Still, there is a lot of work to be done, and certainly this work should focus on end users. As Lipetz noticed, we would be able to fully satisfy information consumers "when researchers gained a deeper understanding of how humans process information and then endowed machines with analogous capabilities" [4]. So far, we have not achieved such a level of cognition, but new technologies are taking us closer to that goal. One of such promising technologies is the Semantic Web [5].

Some people may claim that the Semantic Web (SW) is quite close to aforementioned objective, as it provides means to represent knowledge (or semantics) in a machine processable form. However, models for knowledge representation have existed before the Semantic Web. Assisting humans with means for efficient search and delivery of information remains to be a challenge on the Semantic Web.

For a better understanding of how people look for the information, we have to draw our attention to user aspects of the Semantic Web environments. However, in the literature the technical approach is prevailing. Therefore we observe the opposite results than promised. Although the Semantic Web is gaining popularity, there are still problems with access to the information:

- the Semantic Web is developed mostly in an unsupervised manner, forming isolated "islands" of ontology and technology reuse
- methodologies and tools that are created are not widely accepted
- the Semantic Web is still too vast to a regular user.

Seemingly ironical, information overflow problem is inherited to the Semantic Web as it exists on the Web. In this paper we propose an approach for user-oriented information delivery and search for coping the information overflow problems on the Semantic Web.

The paper is organized as follows. In Section 2, we provide background of the problem and motivation. In Section 3, we analyze current improvements of the search engines, which are inspirations for better information delivery. In Section 4, we propose the information delivery process, and Section 5 concludes the paper.

2 Background

Information delivery is closely related to searching for the information. Therefore, in order to analyze and present problems that end user may encounter while using the Semantic Web, we refer to the search engines. The analysis is supported by a scenario. We also draw a focus on the user aspects. In scenario we supposed that certain communities and their members create ontologies and certain communities and their members provide the data, therefore users of the information systems and their roles are analyzed.

2.1 Google's Lessons

Search engines have been used almost since the Web went public. Now we observe mainly incremental improvements in search engines technology, and only few breakthroughs have been seen. Last significant improvement was done by Google [6]. Unfortunately, since then people have learned how to misuse Google, e.g., utilize PageRank algorithm to manipulate the results. Nevertheless, people got used to good results from Google and expect further improvements.

The common problems in search can be divided into three classes:

- type of content
- the content itself
- bias in weights.

First, restricting search to particular type of content is not possible. We are not thinking about file types (e.g. PDF, PPT), what is already implemented, but more general categories, like “scientific paper”, “article in encyclopedia”, “definition in dictionary”, sale offer, auction etc. Provided that there are similar numbers and importance of referring pages, referred pages are ranked equally no matter if it is a sale offer or scientific publication, or just a fake page containing prepared set of keywords. And of course, for different users it has different importance. For example, users complain that they often get sale offer when looking for artist information instead of informative content, e.g. biography. Giving the possibility to constrain type of content would significantly improve the search results.

Secondly, there is sometimes a problem with the precision of the content. We get the appropriate type of content, but that content is not semantically coherent to what we expected. Google is just missing context of information. When one types “jaguar”, one receives at lest three clusters of information. Within the top results there is information about cars, about big cats, and surprisingly about Apple’s Mac OS X. The last one codenamed Panther is compared to jaguar only in one sentence. Because of the popularity of Apple’s webpage, “jaguar” there also seems to Google to be important, what is not justified. Further experiment, when we type “panther” in Google, the first result is not a web page on cats but also the main page of Apple. The issue of content matching is not resolvable without introduction of semantics and probably certain human intervention.

The last, third, issue is to some extent connected with the first two. Google’s PageRank uses links and keywords to compute weights and create ranking. In most cases it produces superior rankings of pages. On one hand, the bias in weights may be caused unintentionally for example because of the type of content which is generated automatically from the database. On the other hand, algorithm is well known, and people have learned how to manipulate weights. This unfortunately deteriorates the search results. Either we can find information very quickly or it is really hard to find it. We can modify the keywords but it does not always help.

2.2 “I need this specific information”

Suppose that new employee came to the organization and would like to get to know his co-workers. Usually, there is a company webpage that presents the list of all employees, in which department their work, contact information, sometimes responsibilities. This webpage is very formal and contains only information related to the company. Personal information, which is rather crucial in a social life in a company: photos, hobbies, birthdays, etc can be missing. Some of the users may have built their personal pages, but only rarely a link to that page is present on official employee webpage.

The newcomer has some possibilities. One of them is to launch a web browser, go to a search engine and look for the information somewhere in the Internet. Several problems arise: the query should be repeated for every employee. Moreover, the query will not be unambiguous as we have seen in the previous section. Specifying only first name and family name will return hundreds or thousands of pages. The search engine will not distinguish "John Green" that we are looking for among the other people with the same name; hence there is a need to read most of the result pages. And we are not sure if our searches will succeed: does everybody have a webpage? Further, the user is burdened with integration of the information, and it requires additional effort. The problems encountered so far: manual search for the information, collection of the distributed information, extraction of heterogeneous sources, integration of the information, transforming of the aggregated information into visual form. This tedious task may be made easier by using appropriately structured information. There are some solutions that more or less support this, e.g. FOAF – Friend of a Friend [7], but they are not mature yet.

2.3 Users and Roles

According to the class of information systems, we can distinguish different classes of the users. If we look at the Internet, the basic division is into active users and passive users. Passive users just browse the Internet or navigate from page to page, use search engines to find the information. The most characteristic is that they do not contribute with their own information. Active users are the opposite; they publish new content on the Internet. The classification presented is not unambiguous. Some of the users may become active. Therefore it is better to speak about roles (like in workflow management systems). A user may play different roles according to the context or situation. Because main substance exchanged on the Internet is information, we may talk as well about information consumer role and provider role.

Yet another classification of users stems directly from information society, which is supposed to be built by bringing information technology to the masses. User may use IT to the different extent, and thus play different role in information society, therefore we can distinguish [8]:

- self-informing citizens – know the technology, so they are able to acquire relevant information
- communicating citizens – can communicate with other people in an electronic way
- citizens educating themselves – acquire knowledge that determines the quality of their professional and private lives
- creative citizens – can create digital products or provide digital services which meet the needs of self-informing, communicating and educating citizens.

However, if we focus only on information providers (or creating citizens) we will see that they may be further layered. Both user filling in a form and designer of a portal are information providers. Furthermore, the user may provide the content alone, or in collaboration with other users. Also, the scope of the knowledge used may be different: one may be interested only in instances from a knowledge base, another in structure the knowledge base, i.e. in ontologies.

There are different activities related to the information delivery:

- structuring
- editing

- browsing.

First, a framework for knowledge representation should be created. Taking into account contemporary trends it will have a form of ontology. Commitment of many users is required therefore proper management is a must here. Then users may introduce their own information by creation of instances of the concepts taken from the ontology. It may also be done in a collaborative way. The first two activities may be jointly referred to and are covered by ontology management. Finally, another group of users may browse the knowledge base for the required information. As a result of interaction, information may be delivered to the final user.

3 Towards the Semantic Web

Some of the problems addressed in the previous section can be solved by better use of the Semantic Web technology, especially in the support of the end-users. Main problem of search engines consisted in lack of semantics. To convince users of usefulness of the Semantic Web we need clear and easy to use interface and also outstanding search results.

Focus on end user is crucial. Different users differently perceive information. They have different abilities to cope with the abundant information. Also, the amount and type of information they need in their work is not the same for everybody. Taking all the factors that may influence information needs of the user we have obtain a so called user context, which may include user knowledge, user location, user activity. It will be also useful to keep a track of what user looked for and how did find information.

3.1 User Support

People will positively perceive the Semantic Web if it supports them in their activities in an easy manner. Every well-designed information system should suggest how to work with it. Semantic Web shall not be an exception here.

Today we can observe only many small improvements in various search engines. *Google suggest*[1] auto completes the search terms based on a few first letters, working similarly to combo box in Windows. Thus the query may be typed faster. AOL search engine supports users in another way: using its *Smartbox Suggestions* gives access not only to general purpose web search but also to more specialized search engine or even specialized databases, e.g. stock quotes.

In the Semantic Web search users should have the possibility to select options to narrow their query. Sometimes we may want to choose the type of information we are looking for, e.g. white paper, product info, advice from the discussion forum, technical problem, definition, biography etc., not to mention a picture. For a long time Google is offering a special search for pictures. Others also join, e.g. A9.com offers buttons on the right side of the window that allow restricting query for certain

[1] http://www.google.com/webhp?complete=1&hl=en

information: web, books, images, movies, reference, yellow pages. It is also possible to see the history of searches.

Other search engines also collect history of searches. This will be obviously also important in Semantic Web. The user may know that she had found the information once, but cannot remind how. This is especially addressed in one of the Microsoft's projects *Stuff I've seen*[2], which will be included in Longhorn.

All these suggestions cause that if user already knows or may know something, she does not have to start from scratch.

3.2 User Context

Introduction of context will allow answering the question how to intelligently reduce amount of information in an answer to the query. Information needs are related to user activities, therefore it will be useful to take them into account. We can distinguish many contexts: time, space, user's knowledge, users' history etc.

One of the most visible contexts is geographical context. According to Microsoft's MSN Search about a quarter of all searches refer to geographic information[3]. Therefore the user has the possibility to search only pages relating to her location. "NearMe" button can return results based on proximity to a place. Unfortunately, it does not work for Innsbruck. When we typed "Japanese restaurant" or "theatre" there were no results. Typing "Innsbruck restaurant" helped, which shows that the location discovery is not well elaborated.

Another example of geographic information is AOL. It is capable of distinguishing some geographical names, and present possible contexts to the user. However, it does not affect effectiveness of retrieval greatly. It may be useful but not precise. For example "Warsaw (US City)" and "Warsaw (International city)" yield the same results. When we compare "Poland (US City)" and "Poland (country)", the results differ, although they are mixed – no real distinction between city and country.

A noticeable application of geographical context was introduced in January 2005 by A9.com. In the Yellow Pages service it is possible not only to look for information on local businesses but also display their photos taken from the street. Moreover, it is also possible to take a virtual walk and see information about other businesses which are seen on the photo. This feature is called "Block View". Such functionality is available for several cities, including New York, Atlanta, San Francisco and Seattle.

We can also look at context from the results' point of view. One possibility to use context is during query formulation, and another while interpreting results. Some of the search engines present clustered results, e.g. Northern Light. That is also a good proposal for improving usability of the Semantic Web, when users are not aware if there are different meanings of the query. It may be a solution for Google's problem, i.e. too many documents on one topic, and lack of documents for another topic, represented by the same set of keywords.

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[2] http://research.microsoft.com/adapt/sis/

[3] http://www.msn.com

As part of user context we may also consider vertical searches. As in case presented by us in the previous section, users usually have very specific questions, e.g., find me all instances of class Employee. It means that usually they have the idea of what they are looking for. From the interface to the Semantic Web they expect help in refining their queries. Also in this direction we may observe some research. Amazon's A9.com has opened its search site to specialized search engines. Users may select thousands of vertical search options. As Bezos, CEO of Amazon, said, they want to "do for search what RSS has done for content." The added value of this approach is subject-matter expertise; it is very similar to ontology layering: upper-level vs. domain ontologies. In the next section we show that such vertical knowledge bases may be developed by different communities, and thus improving the overall quality. Company expects that there will be a significant number of vertical search engines that will be interested in joining the project. Better search results should be achieved by limiting number of sources that are looked up for relevant information.

3.3 From Databases to the Semantic Web

More and more search engines associate databases with query, for example Yahoo weather, movies on AOL, books on A9.com. As Ramez Naam (MSN Search) said "Having the trusted data, what we know is a right answer, and not asking them to trawl around, that's a huge advantage for the user."

In databases there is a lot of digital content that is usually not visible to the search engines, unless somebody puts some effort on integration. Resources are generated on demand, and therefore it is called a hidden web. It requires different indexing mechanism.

A database is not what the end user would like to use for representing knowledge about the world. It has fixed structure and is not flexible in storing different kinds of information. Nevertheless, it is better to have metadata on it and retrieve information on demand, not just to have to annotate all the documents with sophisticated algorithm without being sure if it is done correctly. For a Semantic Web it is as good basis, but it is not enough. Another issue is delivery of the information. From a database, it is easy to create well annotated documents, but still it is not convenient for information seekers.

So far search engines have developed certain solutions. Ask Jeeves introduces new technology that will further extend the answering capabilities of its engine. New feature is called *Direct Answers From Search* and consist in searching for natural language questions across entire Web rather than focusing on own database. This is the idea closest to the Semantic Web.

3.4 Community-Driven Approach

In contemporary search engines we observe two factors that negatively affect the precision of the returned results:

- information is weakly structured
- lack of human annotations.

The first problem may be overcome by the Semantic Web. It is easy to talk about semantics from the technical point of view. For computers our annotations are merely strings of characters.

The latter problem requires engagement of people. The semantics in order to be used in a broadly understood user context, should be first introduced by somebody else. Thus we came to the point where human intervention is required. Due to the large effort required to create the content, one has to take into account that a large number of users will be involved into creation and evolution of the Semantic Web. For example, semantics of sources may be enhanced by means of ontology acquisition from Web users [9]. We believe that distributed online content developed by user communities strongly influences the information delivery process.

4 Information Delivery

Distributed community-generated Semantic Web content is published and accessed differently comparing to the ordinary Web content. In particular, Web content is normally generated in a centralized way, and a webmaster has an overview of the web-site content and has control over delivery of the content to the final user. For the Semantic Web, existing information search practices (e.g., search engines discussed in Section 2), recommendation practices (e.g., established by Amazon.com), accessibility practices [10] are not sufficient and not trivial to apply. In this section, at first, we present a model for information delivery process of distributed community-driven Semantic Web content. Further, we identify points important for usability and accessibility guidelines for delivering distributed Semantic Web content. Finally, we show that the specified process and guidelines are applicable in the context of the Semantic Web to the "I need this specific information" scenario described in Section 2.

4.1 Information Delivery Process

Generalizing current experiences of presentation and delivery of the distributed community-generated Semantic Web content, we present delivery process for such content. In Fig. 1, the steps of information delivery process on the Semantic Web are depicted.

Initially, content is distributed over the Web as the communities develop and specify it. As for the Web content delivery, the main steps in delivery of the Semantic Web content to the final user are (1) collection, integration and aggregation, (2) filtering or querying, (3) presentation of the content. Meanwhile, unlike the Web content, the Semantic Web content is not necessarily associated with human-oriented presentation data, and therefore presentation of the Semantic Web content to the end user in a human-readable and accessible form is a problem requiring a solution. Below, we identify steps in the overall process of delivery of the distributed Semantic Web content to the end user.

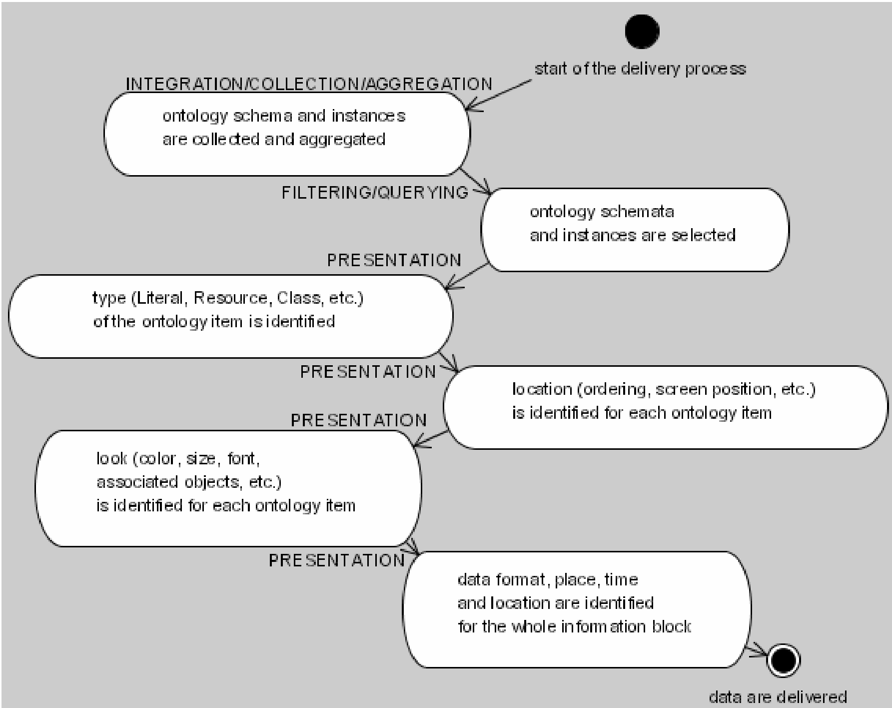

Fig. 1. Information Delivery Process

Collection, Integration and Aggregation step:

1) The ontology schemata and instance data should be continuously integrated, collected and aggregated. This process is similar to indexing known from the classical search engines. There are several solutions that crawl the Web and extract semantic information, e.g., SemanticWebSearch[4]. into information set which is of potential relevance to the final user.

Filtering or querying step:

2) As the amount of data of potential interest to the final user can be larger than the user can access (information overflow problem), the data should be downsized to its subset.

   There can be two different approaches to get information from the Semantic Web: push and pull. The first one can be related to already known information filtering. In this case user gets overview of changes in the Semantic Web according to her profile. Profile represents relatively stable information needs. The latter one resembles information retrieval, where user specifies queries. Query represents temporary user needs. Unlike in the first case, this delivery is done on demand.

[4] http://www.semanticwebsearch.com

Presentation steps:

3) The ontology instances should be identified by type. Knowing the type of the instances is necessary, as a mechanism of rendering can be specified with the help of ontologies supporting rendering processes. For example, an instance of a class *Person* can be specified to be shown in a specific color with certain associated ontology concept or property values, such as *Name* and *Email address*.
4) The location of the ontology and ontology items (classes, properties, instances, etc.) on the screen is established. Specifically, the order of the items on the screen and their positions are established.
5) At this step, visual characteristics of each ontology item should be identified, such as the item's color, size, font and objects that are associated with an item and need to be shown on the screen for adequate rendering of the item. Such associated objects can be images, multimedia, etc.
6) At the last step, the commonly used personalization techniques [11] are applied, namely delivery of information relevant to an individual or a group of individuals in the format and layout specified and in time intervals specified.

After all the steps are executed in turn, the data are being delivered to the end user.

4.2 Information Delivery Interfaces

In this subsection, we identify the application and human related features substantial for the development of the information delivery processes, and illustrate them with the state-of-the art examples. We focus on the end user interfaces resulting after presentation steps of the information delivery process of the Semantic Web content, and particularly, on their accessibility and usability. Despite a high number of works on Semantic Web visualization [12], accessibility and usability features of user-side of Semantic Web content delivery interfaces were not explicitly identified before.

4.2.1 Interfaces for Semantic Web Applications

The following features are substantial in construction of information delivery related interfaces for the Semantic Web applications.

1) Satisfying Software-Related Requirements: Content Negotiation

When an application (e.g., a Web browser) requests information, reception of different content depending on the requester (e.g., graphical images if they are supported by the application or a textual description otherwise) is possible[5]. However, existing protocols do not allow applications to request ontological data of certan types, i.e., operation with Semantic Web annotations remains underspecified in the content negotiation practices.

[5] Apache HTTP Server Content Negotiation, http://httpd.apache.org/docs/ content-negotiation.html

2) Satisfying Hardware-Related Requirements: Different Reception Devices

As well as the Web content, the Semantic Web content can be accessed with different means: personal computers, mobile phones, etc. The delivered content depends on the device of delivery by quality and quantity. Supporting negotiation techniques for identification of the content preferred by the device on the basis of semantic annotations would be a step towards semantically enabled cross-device information delivery.

4.2.2 Interfaces for Human Users

The following features are substantial in construction of information-rendering end user interfaces on the Semantic Web.

1) Supporting Simple-to-use Navigation and Orientation

Web pages, resulting from Semantic Web content and further post-processing, should enable the final user to easily locate the required data on the pages, and easily switch to accessing next sets of Semantic Web content.

2) Making the Context of the Information Explicit to the User

Keeping the user aware of the context of the represented material is important. For example, if an application allows a user to change ontology items, the user should be aware of the consequences of his/her changes. Another example, if a user requests for information about "Warsaw", the presentation of the ontological content should keep the user aware whether information about an US or Polish city is delivered.

3) Automatically Organizing Semantic Web Content on the Device of the End User

Information of arbitrary quantity and quality arriving to the end user should be organized on the user's receiving device (e.g. computer screen) in an accessible way without causing information overload on the page. If necessary, information can be presented on several cross-linked pages. On the Semantic Web, ontology-based algorithms can be applied to describe, analyze and adequately render arriving information. For example, after analysis of social networks of trust [13], information from less trusted sources can be automatically displayed in a less highlighted manner comparing to the information from more trusted sources.

4) Providing Visual Links to Semantic Web Annotations

Despite that the Semantic Web content is primarily made for machine consumption, experience reveals that humans expect to have a visible link to the Semantic data. In particular, buttons providing a link to the Semantic annotations are present at many applications delivering Semantic Web content, e.g., Knowledge Web portal[6] (Fig. 2) and People's Portal [9] .

[6] Knowledge Web portal: http://knowledgeweb.semanticweb.org

Fig. 2. Access to Information Editing at the Knowledge Web Portal

5) Supporting Internationalization and Multilingualism

End users worldwide use different natural languages for communication. Delivering information in the most preferable natural language to the end user is another challenge for the Semantic Web applications. At the moment, there are agreed ways to annotate resources represented in certain natural languages (e.g., using XML and languages layered on top of XML). An ability to understand a certain language or a cultural context can be encoded in (semantic) profiles of individual users and user communities (e.g., adopting FOAF). When such user profiles are broadly available, matching resources and profiles to identify the content in the preferred natural language or cultural context is possible as a part of filtering step (step 2) in the information delivery process.

6) Supporting Disabled Users and Users with Special Requirements

Similar to the preferences of accessing information using one or another natural language, users might need to have the information rendered in special ways such as in an enlarged font (in case of poor sight), in a more granular manner (in case of employment of a small screen), etc. Information delivery in a manner accessible to disabled users and users with special requirements can also be assisted by specifying accessibility details in (semantic)-profiles of users and user communities, and taking data from these profiles as an input in information delivery process at the steps 3, 5, 6 (cf. subsection 4.1).

4.3 The Semantic Web Answer to the "I need this specific information" Scenario

As the information delivery process on the Semantic Web is specified, one can see that the integration, collection, aggregation and filtering, querying parts of the process become more formalized comparing to the Web. Meanwhile, the presentation part of the information delivery on the Semantic Web becomes a challenge. Unlike the Web applications, the Semantic Web applications normally need to render metadata which are evolving independently of visualization mechanisms for these specific data.

Let us consider the described in section 2 "I need this specific information" scenario, where a person starts to work in a new company and is interested in knowing more about her colleagues. If a company had a framework for representation of personal information, there could be one repository for holding references to chunks of personal information specified in semantic annotations. The scope of the information would be defined in an ontology. Every employee could update his personal information in conformance with the ontologies shared by the company members. This personal information could be easy to integrate and query. And the query that could be asked by a newcomer will be as easy as "show me all the instances of a class "http://www.mynewcompany.com/Employee" who have the value of attribute "http://www.mynewcompany.com/Hobby" specified. Meanwhile, as the company employees can evolve and query their profiles in an arbitrary manner, even a simple query might unexpectedly yield information set, presentation of which is not predefined in the framework. Therefore, developers of the applications delivering Semantic Web content to the end user should pay specific attention to ensuring accessibility and usability of the resulting interfaces.

5 Conclusions

Summarizing, there are not yet developed appropriate techniques to effectively support user in the usage of the Semantic Web. The technology starts to exist in the end-users' minds, but there are no agreements on what it actually is. There are also claims undermining the potential of this technology, stating that there are no problems to solve [14]. But indeed there are many problems.

Since the technology is promising and many people are eager to use it, we should think how encourage users of the Semantic Web. User interfaces are one of the issues, which we discussed in this paper. Security, immunity to exploitation and privacy are important issues here.

We foresee problems, and techniques for coping with them should be developed in advance. One of the problems is that the Semantic Web might not meet the users' expectations. When the Semantic Web technology becomes widespread, more and more people will contribute. The quality of contribution might become a problem. Therefore, measures should be taken to make sure that real collaboration on the Semantic Web occurs, and not only what we can call semi-collaboration – people publishing content without conforming to certain standards and propagating their own practices.. Having failed on establishment of community-driven approaches and collaboration will imply that users still will have the problems with finding relevant and credible information, even after introduction of the Semantic Web.

From users' point of view it is relatively easy to define requirements that will enable broad acceptance of this technology. Using the Semantic Web should be as easy as asking an expert for an advice or a friend for a rumor, and just getting an answer, without further need to process the information (e.g. read the document). Taking this approach we have to acknowledge that the Semantic Web should be invisible for the user, no matter how sophisticated are the underlying algorithms. Still those algorithms should also be improved.

Acknowledgement

The work is partly supported by the European Commission under the Marie Curie ToK *enIRaF* (IST-509766) and NoE *KnowledgeWeb* (IST-2004-507482).

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