Semantic Wikis

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"Semantic Wikis" combine properties of Wikis (like ease of use, collaboration, linking) with Semantic Web technology (like structured content, knowledge models in form of ontologies, reasoning). Recently, Semantic Wikis have gained considerable attention, as they connect "social intelligence" and "artificial intelligence", support the user in ways that are not available in normal wikis, and allow an easy introduction to novel Semantic Web technologies, which are arguably still hard to grasp in other areas. The aim of this article is to give an overview over the topic "Semantic Wikis". We give particular focus to application fields and briefly compare selected systems based on their different approaches.

Wiki and Semantic Wiki

A *Wiki* is a web-based system that enables collaborative editing of Web pages. The most important properties of Wikis are their *openness*, allowing each user to participate in the creation of content, and their *flexibility* with regards to the different working styles of different users, without restricting the user by technological constraints ("dictate of the system"). Additional properties are a web-based text editor with a simple markup language to create content and to easily link between pages, a versioning system to track content changes, as well as full text search allowing to query all pages in a Wiki.

When using a Wiki, full text search often proves to be insufficient for retrieving relevant knowledge–e.g., when trying to find structured data (in contrast to unstructured content) or when trying to find related pages. For instance, Wikipedia contains an abundance of structured data related to persons (e.g., date and place of birth, important works, ...) and cities (e.g., geo coordinates, relations like *located-in*, ...). To make such data more accessible for users, Wikis usually follow two approaches: on the one hand, most Wikis contain manually updated overview pages that sort pages according to certain criteria; however, this usually involves a lot of maintenance work. On the other hand, most Wiki systems offer additional tools like categories, extensions for certain kinds of metadata (e.g., calendars), and template mechanisms that predefine the structure for certain kinds of pages. However, category systems are quite inflexible, and specfic extensions are restricted to certain kinds of metadata, and it needs to be evaluated whether the benefit outweighs the user time needed for learning the extension functionality.

A *Semantic Wiki* tries to extend the flexibility of a normal Wiki with regards to textual content to structured data. To this aim, it supports metadata in form of semantic annotations of wiki pages themselves and of the links/relations between wiki pages.[1] Semantic annotations can then be used for extended queries or even for adaptation of the content presentation to different users and domains.

The term "Semantic Wiki" is used for a wide variety of different systems. In general, Semantic Wikis combine Semantic Web technologies with the functionalities of a normal Wiki. The internal representation of annotations with RDF/OWL simplifies the exchange of data with other applications. For example, this allows for external search functionality–e.g., as a Web service. Furthermore, it is possible to use deductive reasoning to derive additional information. Beyond these features, Semantic Wikis offer the following functionalities:

- a simple formalism for semantically annotating links and wiki articles or other kinds of content
- a semantic search allowing to query not only by keyword but also by semantic relations between objects–e.g., by topic ("EU projects") or even indirectly ("meeting minutes of EU projects")
- possibly an additional (semi-)automatic extraction of metadata from wiki articles to simplify the process of annotating

The different Semantic Wiki systems follow different goals: some aim to simplify navigation and collaboration by using semantic annotations, while others want to establish Wikis as a means to collaboratively create ontologies for the Semantic Web. The salient research and development aspect of Semantic Wikis thus lies between the adoption of Semantic Web technologies for Wikis and the use of Wikis for the Semantic Web. In a sense, a Semantic Wiki can therefore be considered as the "Semantic Web in small".

Semantic Wiki by Example

The ontology within a Semantic Wiki is created and maintained by associating with each instance and concept of the ontology a page in the wiki. Using Wiki links and annotations, the concepts/pages are related with each other. Semantic Wikis follow two different approaches for annotation: while most provide an extended wiki link syntax within the textual editor, some provide form- or AJAX-based annotations in a separate annotations editor.

Figure 1 shows the textual annotation in *Semantic MediaWiki* [SMW]. For instance, the annotation `[[coded in::Java]]` denotes that there is a relation *coded in* between the concepts *IkeWiki* and *Java*. This formally represented annotation can then e.g. be used to query for all *Semantic Wikis* that are written in *Java*.

[1] Semantic annotations usually correspond to an ontology defining which properties can be associated with which object types. the ontology is also edited and maintained within the Semantic Wiki system. Knowledge models are usually represented using the languages RDF/S and OWL.

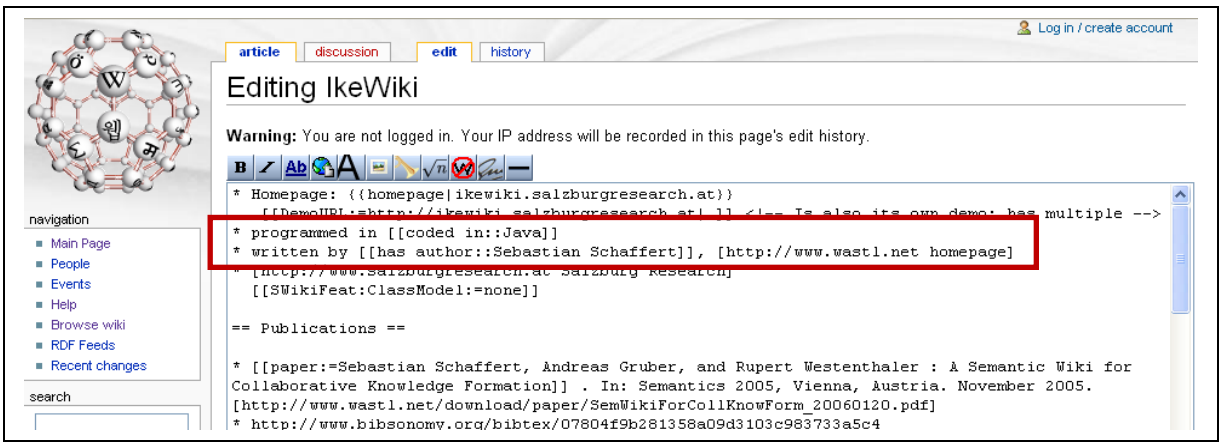

Abbildung 1: Semantische Annotation am Beispiel des Systems *Semantic MediaWiki*

Form based annotation with the system IkeWiki [IkeWiki] is shown in Figure 2. The figure illustrates the formal annotation of the term *Bilberry* in a biology application. The system allows users to create and annotate not only links and pages, but also ontology classes and properties.

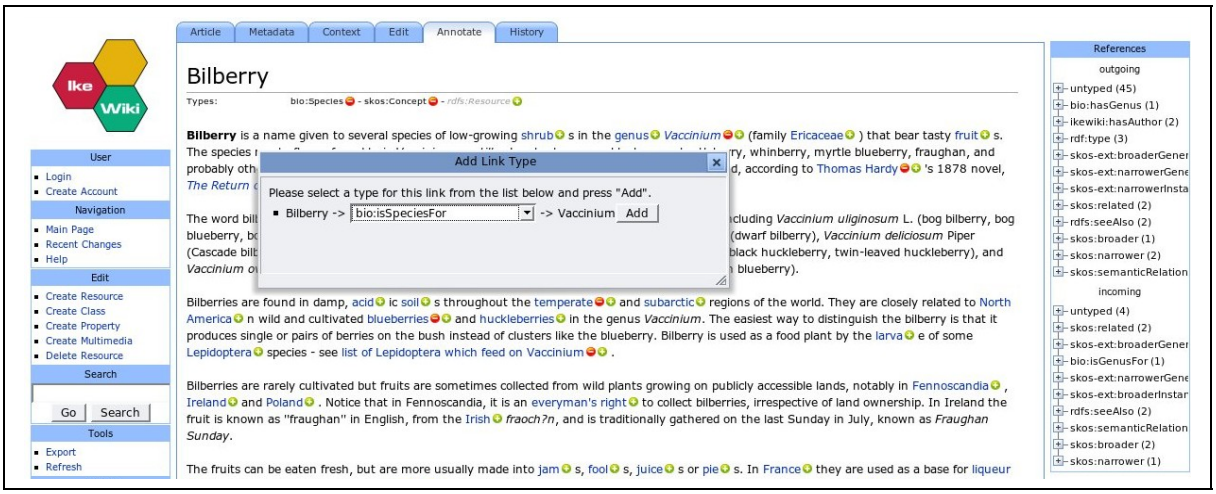

Abbildung 2: Semantische Annotationen am Beispiel des Systems *IkeWiki*

Associated types of an article are listed below the page title (in the example: *bio:Species*, *skos:Concept*, *rdfs:Resource*); already annotated links in the text are marked by icons; relations to other wiki articles and ontology concepts are listed under *References* on the right side and visualise the existing annotations. This "reference box" also aims to ease navigation through the evolving semantic network. Clicking on the "+" symbols behind a link or type opens a form that allows to add additional annotations to the page. Figure 2 demonstrates the annotation of a link between the subject *Bilberry* and the object *Vaccinium* with the relation *bio:isSpeciesFor*. The

user can choose from a list of properties defined in an underlying knowledge model and does not need a priori knowledge about the available annotations.

System Comparison

In the following, we try to summarise the major features of some selected Semantic Wiki systems. Please keep in mind, though, that many of these systems are currently still only available as research prototypes whose features are subject to change very quickly.

Semantic MediaWiki[2] concentrates on the Wikipedia/encyclopedia scenario and therefore emphasises scalability and backwards compatibility. In addition, Semantic MediaWiki does not require a predefined schema or ontology for annotations – users can add new annotations as needed, similar to tagging systems. Since efficient and freely available inference systems that scale up to the size if Wikipedia are not foreseeable in the near future, Semantic MediaWiki does not support inferencing and similar advanced functionalities.

IkeWiki[3] is developed as a Java Web application and has originally been developed as a tool for collaboratively developing ontologies and for knowledge management purposes. In contrast to Semantic MediaWiki, the focus lies primarily on providing advanced semantic functionalities like reasoning, so as to support the user as much as possible in her tasks; to provide these functionalities, IkeWiki accepts a lower scalability and higher hardware demands. IkeWiki supports usage as well as editing of OWL ontologies, and can be configured to use OWL-RDS or OWL-DL reasoning. A rule-based inference mechanism is currently under development.

Kaukolu[4] is a research prototype based on JSPWiki. It allows annotations with extended Wiki markup as well as form-based annotations that are dynamically built from underlying ontologies. Annotations can also refer to arbitrary parts of a page and are not limited to the whole page. Annotations can also be generated automatically by external systems; currently, there are experiments using eyetracking to do this. One application scenario is the annotation of existing documents like juridical texts.

SWEET Wiki[5] is a research prototype from INRIA Sophia-Antipolis and is implemented in Java. A salient aspect of SWEET Wiki is the combination of social tagging with formal ontologies. Users can easily annotate pages with arbitrary tags, which in turn may be associated with concepts from the underlying ontologies. In addition, SWEET Wiki uses the CORESE inference machine developed for conceptual graphs which offers many reasoning

2 http://ontoworld.org/wiki/Semantic_MediaWiki
3 http://ikewiki.salzburgresearch.at/
4 http://kaukoluwiki.opendfki.de/
5 http://wwwsop.inria.fr/acacia/soft/sweetwiki.html

services.

OntoWiki[6] differs from the above-mentioned systems in that classical textual content is no longer in the foreground. Instead, OntoWiki offers an easy-to-use interface for collaboratively creating and maintaing ontologies. A further salient aspect is the support of semantic search and navigation, as well as the possibility to version metadata.

Like for normal Wikis, there will not be a "Standard Semantic Wiki", because each of the systems has its own, justified focus and its own strengths and weaknesses. An extensive overview over Semantic Wikis is given in the Ontoworld Wiki.[7]

Application Areas

Semantic Wikis being an extension of normal Wikis, there is obviously a large overlap of application areas. Beyond normal Wikis, however, Semantic Wikis can – by using explicit representation of metadata – offer significant support in most application areas by providing improved navigation and search, context dependent presentation or personalisation, etc. In the following, we present two exemplary application areas that illustrate the different aspects of using Semantic Wikis: *knowledge management* and *ontology engineering*.

Knowledge Management. In recent years, Wikis are increasingly used as tools to support knowledge management. For example, many companies use Wikis to maintain and share knowledge about software projects (source code, documentation, project workplans, bug reports, etc). Knowledge captured in this fashion is easy to *create*, but increasingly difficult to *retrieve*; it is often even distributed over a multitude of different Wiki installations. For example, development of the Netbeans IDE at Sun Microsystems is currently supported by more than a dozen Wikis that are not integrated with each other.

Semantic Wikis have the potential to solve these problems without sacrificing the flexibility and openness of Wikis. Where semantic annotations and hence structures are available, the system can actively support the user–e.g., by appropriate visualisations of a semantically represented project plan, by exchanging annotations with other Wikis or even applications, or by offering a semantic search function. Where no semantic annotations are available (yet), a Semantic Wiki still offers the same functionality as an ordinary Wiki. Like in an ordinary Wiki, where many short term users are often contributing content, but a few long term users ("gardeners") are constantly maintaining the system, short term users in a normal Wiki can add small pieces of information, while long term users take care of properly structuring the content. A nice side effect of this "evolutionary formalisation" is that users can have an instant benefit for the additional effort of annotation, which is a crucial factor for motivating users. Knowledge management in Semantic Wikis is currently investigated in several major EU projects: *KIWI*[8]

[6] http://3ba.se

[7] http://wiki.ontoworld.org/wiki/Category:Semantic_wiki

[8] http://www.kiwi-project.eu

(Knowledge in a Wiki) and NEPOMUK[9] (Social Semantic Desktop).

Ontology Engineering. Developing an ontology for the Semantic Web is currently a very daunting task. A major problem is that domain experts (e.g., biologists) know there respective domain very well, but do not have sufficient expertise in knowledge management formalisms, and on the other hand computer scientists have sufficient knowledge about the formalisms but not about the respective domains. For this reason, most high-quality ontologies outside Computer Science exist in some special areas like medicine or biology where the high effort is acceptable.

Semantic Wikis can significantly simplify ontology engineering. Starting from textual descriptions in Wiki pages created by domain experts, knowledge can successively be formalised by close interaction between domain experts and computer scientists. The ontology that evolved in this fashion can then be further refined in other tools or applications. Semantic Wikis are also interesting for updating and maintaining an ontology. While tools like Protégé require understanding of the underlying formalism, most changes in a Semantic Wiki can also be performed by domain experts. First experiences made in the project *Dynamont*[10] are promising.

Summary

In comparison to ordinary Wikis, Semantic Wikis offer an explicit representation of the contained knowledge through semantic annotations. For example, this extension allows the use of semantic search, automatic deduction, and intelligent navigation. Typical application areas are collaborative knowledge management and ontology engineering.

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[9] http://nepomuk.semanticdesktop.org/

[10] http://dynamont.factlink.net

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