# Semantic Wikis: A Comprehensible Introduction with Examples from the Health Sciences

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***Abstract*—This paper provides a concise introduction to semantic wikis. It also offers pointers to useful online resources about the subject, and presents some semantic wiki examples from the health and healthcare sciences.**

***Index Terms*—semantic wikis, semantic web, social web, medicine and health**

## I. What Is a Semantic Wiki?

Articles in regular wikis have structured, formatted text (intended for humans to read and understand) and untyped hyperlinks to other related articles within the wiki (again intended for humans to follow). Semantic wikis provide the ability to capture (by humans), store and later identify (by machines) further meta-information or metadata about those articles and hyperlinks, as well as their relations.

Let us consider a semantic wiki devoted to the discipline of microbiology (covering microbes and agents acting against them). The page for penicillin would contain, in addition to standard text information, some machine-readable semantic information, e.g., that penicillin is a kind of antibiotic - what is known as an 'inheritance relationship'. The wiki would thus be able to automatically generate a list of antibiotics, simply by listing all pages that are tagged as being of type 'antibiotic'. More complex metadata and relationships can also be stored, e.g., the subclass of antibiotics to which penicillin belongs (beta-lactam antibiotics) and its spectrum of action (Gram-positive organisms). Some of this information could be automatically derived from the free text (by the machine), but the chances of errors and inaccuracies when using free text (intended for humans) would be higher. If the semantic wiki exports all its attribute and relation data in RDF (Resource Description Framework - http://www.w3.org/RDF/) or a similar format, it can then be queried in formal ways like a database, so that a user or external Web site could, for instance, submit a query to get a list of all antibiotics that are beta-lactams AND effective against Gram-positive organisms (for more details, see [1] and [2]).

Semantic wikis combine the strengths of the social "Web 2.0" and the Semantic Web [3], while also overcoming some of their respective weaknesses or deficiencies (Fig. 1). The latter issues include the search and information retrieval problems experienced in today's social "Web 2.0", with its "uncontrolled" or "loose" folksonomies (social tagging) and not uncommonly Lemmings-like 'wisdom of the crowds'; the apparent complexity, relative "restrictiveness" and "over formalism"/inaccessibility of pure Semantic Web methods (from the viewpoint of ordinary end-users, especially those of them who also want to collaborate on common Web projects); and the increasingly non-textual, multimedia and collaborative natures of the Web, which present many search/information retrieval, online collaboration and personalization challenges, requiring novel and fresh approaches to properly address them over the coming years.

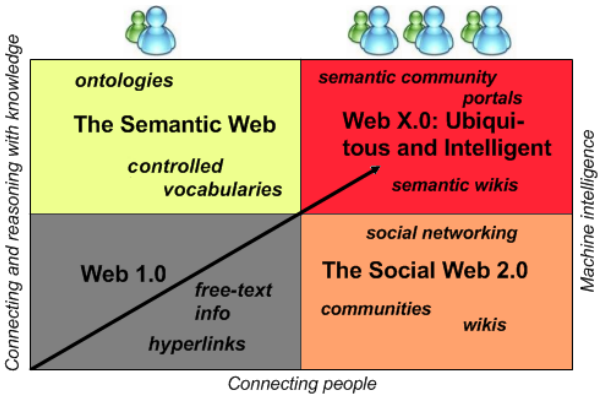


Figure 1. Going beyond "Web 1.0", "Web 2.0" and the Semantic Web [Modified from Nova Spivak, Radar Networks; John Breslin, DERI; & Mills Davis, Project10X (http://www.project10x.com/ and http://www.isoco.com/pdf/Semantic_Wave_2008-Executive_summary.pdf).].

One of the most promising semantic wiki implementations currently in development and use is the Semantic MediaWiki (http://semantic-mediawiki.org/), an extension to MediaWiki (the popular wiki application on which Wikipedia and many other wiki sites run) that allows for the encoding of semantic data within wiki pages, thus turning a wiki that includes the extension into a 'semantic wiki'. In the above example about penicillin, the Semantic MediaWiki syntax (in the page source) would be:

*... is a type of [[Is type of::antibiotics]] ...*

which is semantically equivalent to the statement 'Penicillin' 'Is type of' 'antibiotics'.

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There are a growing number of Semantic MediaWiki extensions on offer today for adding and modifying data (e.g., Semantic Forms and Halo Extension), searching and browsing (e.g., Halo Extension and Semantic Drilldown), displaying data (e.g., Semantic Google Maps and Semantic Gallery), importing and exporting data (e.g., Data Transfer) and other purposes. Details of these extensions and others can be found at http://www.mediawiki.org/wiki/Category:SemanticMediaWiki_extensions.

Other semantic wiki engines include AceWiki (http://attempto.ifi.uzh.ch/acewiki/), BOWiki (http://bowiki.net/ - [4]), KiWi (http://www.kiwi-project.eu/), Subleme (http://code.google.com/p/subleme/), SweetWiki (http://www-sop.inria.fr/teams/edelweiss/wiki/wakka.php?wiki=SweetWiki – [5]) and many more (see list at http://semanticweb.org/wiki/Semantic_Wiki_State_Of_The_Art#Active).

Table 1 lists some key online resources about semantic wikis that can be accessed to learn more about the subject.

TABLE I.
SOME KEY ONLINE RESOURCES ABOUT SEMANTIC WIKIS

| |
|---|
| **"Semantic Wiki" mini-series**<br>http://ontolog.cim3.net/cgi-bin/wiki.pl?SemanticWiki |
| **A Survey of the Landscape and State-of-Art in Semantic Wiki**<br>http://ontolog.cim3.net/cgi-bin/wiki.pl?ConferenceCall_2008_10_23 |
| **SemWiki.org - The Semantic Wiki Community**<br>http://www.semwiki.org/ |
| **Papers presented at SemWiki2006, the 1st Workshop: "SemWiki2006 - From Wiki to Semantics", co-located with the ESWC2006 in Budva (Montenegro)**<br>http://semanticweb.org/wiki/Accepted_papers_at_SemWiki2006 |

## II. EXAMPLES AND POTENTIAL

A good example of a current semantic wiki implementation in the health and healthcare sciences is the WikiNeuron project at Yale Center for Medical Informatics (http://neuroweb3.med.yale.edu/mediawiki/index.php/WikiNeuron). WikiNeuron was conceived for collaborative knowledge acquisition, annotation, and integration in neurosciences, and is implemented using Semantic MediaWiki. It features an internal semantic query language, supports RDF data export, and uses specialised extensions like the Halo Extension (http://semanticweb.org/wiki/Halo_Extension and http://www.mediawiki.org/wiki/Extension:Halo_Extension), an extension that has been developed in order to facilitate the use of semantic wikis for a large community of users by providing additional features and functionality to enhance wiki navigation, improve semantic data authoring, and simplify knowledge retrieval.

Other biomedical examples of semantic wikis include LexWiki Distributed Terminology Development Platform (http://informatics.mayo.edu/vkcdemo/lexwiki1/index.php/Main_Page), a collaborative content development platform based on Semantic MediaWiki, and LexWiki's use cases. LexWiki is an Open Source, high-capacity editor for distributed terminology development, and is being developed by Mayo Clinic in collaboration with the National Cancer Institute (NCI), Standford University, and the World Health Organization (WHO - see an overview of the 'WHO ICD11 Wiki' use case of LexWiki at http://ontolog.cim3.net/file/work/SemanticWiki/SWiki-04_Application-1_20090122/LexWiki-ICD--Guoqian Jiang_20090122.pdf). The NCI Biomedical Grid Terminology (BiomedGT), a specific instance or use case of LexWiki, is an open terminology for translational research and is being developed on the BiomedGT Collaborative Ontology Development Wiki (http://biomedgt.nci.nih.gov/wiki/index.php/Main_Page).

The Hesperian Online Digital Library (http://www.hesperian.net/health/Main_Page - requires a username/password to access, which can be requested at http://www.hesperian.net/ - hesperian@hesperian.org), a collaboration between the Hesperian Foundation (a non-profit US publisher of books and newsletters for community-based healthcare) and the University of California, Berkeley (http://www.eecs.berkeley.edu/Research/Projects/Data/105520.html), is another health-oriented semantic wiki example supporting 'semantic queries' (http://www.hesperian.net/health/Main_Page#Structured_Queries--_Examples – Fig. 2). Ziesche [6] describes how semantic wikis can help in disaster relief operations.

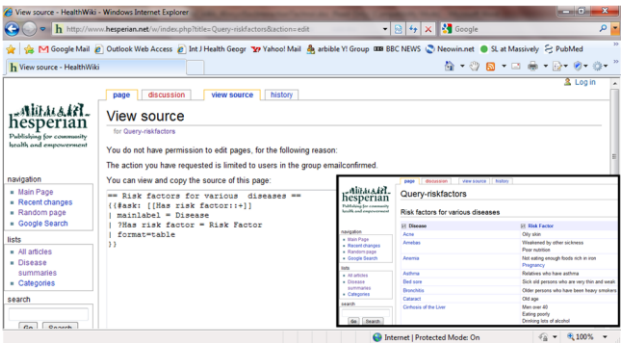


Figure 2. Source (syntax) of a semantic query about 'risk factors for various diseases' in the Hesperian Online Digital Library (http://www.hesperian.net/w/index.php?title=Query-riskfactors&action=edit). The results of this query can be seen on the corresponding 'page' tab (http://www.hesperian.net/health/Query-riskfactors - Fig. 2 inset).

In the future, the semantic wiki concept might also prove useful in enabling on-the-fly, almost fully automated article remixing and mashups, e.g., combining an article about depression written by some author (according to some given 'semantic' query/quality criteria) with another one written by same or another author about one of the drugs available to treat depression (again according to some given 'semantic' query/quality criteria) to produce a more comprehensive output article about depression and its treatment. Such 'semantic' mashups could also retain the link to most current version of the original sources (via on-the-fly semantic queries), so that if those sources are revised, the changes would always be immediately propagated to the output "mashed-up" article when recalled, thus keeping it up-to-date.

## III. CONCLUSION

When it comes to complex domains with hundreds of thousands of concepts/entities, synonyms and heavy ontological relationships (like medicine), the next-generation 'semantic wikis' have the potential of providing some excellent knowledge management solutions to specialist communities and general consumers alike, beyond the current offerings and affordances of mainstream "Web 2.0" wikis and mashups.

## APPENDIX A DEFINITIONS

*Semantic Web:* The Semantic Web initiative aims at creating a Web where information semantics (or meaning) are represented in a form that can be "understood" by machines as well as by humans. This will pave the way to more "intelligent" machine-to-machine communication and information agent interoperability, and should ultimately empower human Web readers and solve many of the information management and retrieval problems they experience today with the current Web, including in Web 2.0 applications (for more details, see [1], [2], and http://protege.cim3.net/file/pub/ontologies/dublin-core/hcm_dc_in_protege_newcastle.pdf).

*"Web 2.0" Wikis:* A wiki (from the Hawaiian wiki, to hurry, swift) is a collaborative Web site whose content can be edited by anyone who has access to it (subject to any editing rights/protection set by the wiki administrator—it is possible to make editing open to everyone). Perhaps the best example of a wiki in action today is 'Wikipedia' http://en.wikipedia.org/ (for more details, see [7] and [8]).

## REFERENCES

Note: All URLs in this manuscript have been last accessed on June 4, 2009.

[1] M. N. Kamel Boulos, A. V. Roudsari, and E. R. Carson, "Towards a semantic medical Web: HealthCyberMap's tool for building an RDF metadata base of health information resources based on the Qualified Dublin Core Metadata Set," *Med. Sci. Monit.*, vol. 8, iss. 7, pp. MT124-36, 2002 (http://www.ncbi.nlm.nih.gov/pubmed/12118210).

[2] M.N. Kamel Boulos, "A first look at HealthCyberMap medical semantic subject search engine," *Technol. Health Care*, vol. 12, iss. 1, pp. 33-41, 2004 (http://portal.acm.org/citation.cfm?id=1011150).

[3] M. Völkel, M. Krötzsch, D. Vrandecic, H. Haller, and R. Studer, "Semantic Wikipedia," in *Proceedings of the 15th international conference on World Wide Web, WWW 2006, Edinburgh, Scotland, May 23-26, 2006* (http://www.aifb.uni-karlsruhe.de/Publikationen/showPublikation_english?publ_id=1055).

[4] R. Hoehndorf, J. Bacher, M. Backhaus, S. E. Gregorio Jr., F. Loebe, K. Prüfer, A. Uciteli, J. Visagie, H. Herre, and J.Kelso, "BOWiki: an ontology-based wiki for annotation of data and integration of knowledge in biology," *BMC Bioinformatics*, vol. 10, suppl. 5:S5, May 2009 (http://www.biomedcentral.com/1471-2105/10/S5/S5).

[5] M. Buffa, F. Gandon, G. Ereteo, P. Sander, and C. Faron, "SweetWiki: A semantic wiki," *Journal of Web Semantics*, vol. 6, iss. 1, pp. 84-97, February 2008 (http://dx.doi.org/10.1016/j.websem.2007.11.003).

[6] S. Ziesche, "Semantic Wikis and Disaster Relief Operations," *XML.com*, 13 December 2006 (http://www.xml.com/pub/a/2006/12/13/semantic-wikis-and-disaster-relief-operations.html).

[7] M. N. Kamel Boulos, I. Maramba, and S. Wheeler, "Wikis, blogs and podcasts: a new generation of Web-based tools for virtual collaborative clinical practice and education," *BMC Med. Educ.*, vol. 6, iss. 41, August 2006 (http://www.biomedcentral.com/1472-6920/6/41).

[8] M.N. Kamel Boulos and S. Wheeler, "The emerging Web 2.0 social software: an enabling suite of sociable technologies in health and healthcare education," *Health Info. Libr. J.*, vol. 24, iss. 1, pp. 2-23, March 2007 (http://www.ncbi.nlm.nih.gov/pubmed/17331140).

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