Metadata creation in socio-semantic tagging systems: Towards holistic knowledge creation and interchange

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Abstract. Fuzzzy.com, a social bookmarking website has been developed to study collaborative creation of semantics. In a shared online space, users of Fuzzzy continuously create metadata bottom-up by categorizing (tagging) favourite hyperlinks (bookmarks). The semantic network of tags created by users evolves into a people's fuzzy common ontology ("folktology"). We discuss several social and cognitive aspects of Topic Maps technology and scalability by analyzing the use of the system. We further argue that holistic knowledge creation and interchange is highly needed. Our results from Fuzzzy suggest that this cause will be rightly served by connecting distributed and well-defined communities of dedicated users within specific domains, having a clear knowledge-centric purpose.

1 Introduction

Studies have shown that there is clear reluctance among both users and institutions to create metadata [1]. This threatens to cause the Web to sink in to the morass of information overload and become a source of frustration.

There is also the need for existing metadata to be updated. Manual creation and updating is costly. Automatic processing often leads to poor quality because it is inferior to human reasoning [2].

In dynamic and evolving knowledge-centric communities, knowledge structures must be able to evolve and adapt. Semantic Web research has revealed that one of the most challenging tasks is the development and maintenance of ontologies. Although several languages for computer-mediated ontologies now exist, the creation and managing of these ontologies has remained time-consuming and difficult, and it often requires the involvement of both domain experts and ontology engineers [3],[4],[5],[6],[7]. In recent years we have seen diverse research targeting ontology creation and management with approaches ranging from automatic inferencing to ontology engineering methodologies and collaborative environments for achieving consensus on ontologies [8]. Among the most widely researched approach to ontology creation is the Self-annotating Web paradigm [9], with the principle idea of using the available data of the Web to automatically create semantics.

Our approach to the problem of ontology evolution is the pragmatic approach of the Socio-semantic Web (S2W), which uses humanly created loose semantics to fulfil the vision of the Semantic Web [10]. Instead of relying entirely on formal ontologies and automated inferencing, humans, aided by socio-semantic systems, are collaboratively building semantics [11].

Folksonomies [12] have become widely popular in recent years because of their ease of use. Folksonomies and ontologies can be placed at two opposite ends of the categorisation spectrum. The process commonly known as “tagging” has proven to be effective for creation of metadata. However, the quality of metadata created by folksonomy tagging is poor [13],[14],[15]. Also, current folksonomies used by popular sites such as Del.icio.us and flickr.com do not allow for sharing tags between applications [16]. Fuzzzy.com, which is described in this article, is the result of an adaptation of the folksonomy approach to ontology development, an approach which we label as ‘folktology’.

Our contributions are two-fold. On the one side, we draw insights from the experience with Fuzzzy to discuss the feasibility of the folktology approach, and to suggest improvements which will make this approach feasible. On the other side, we report on several technical solutions for folktology building that have evolved through the development of Fuzzzy, and we suggest extensions and improvements, which will be implemented within our projected Holoscopia platform.

The rest of the article is in two parts. The first part is concerned with socio-semantic aspects of metadata creation. We present Fuzzzy.com and its folktology, and we evaluate the ontology-near categorization method of the Fuzzzy folktology by comparing it against folksonomies. We end the first part by discussing the unsolved issues of the Fuzzzy folktology, the main of which is the still persisting user reluctance to create metadata.. In the second part we propose a strategy for resolving those issues.

2 Fuzzzy.com

In folksonomy-based systems tag-to-tag relations are inferred by the tags different users have applied to the same resources. In the Fuzzzy folktology, on the other hand, tag-to-tag relations are explicitly added by users.

2.1 Some core ideas

The main concepts of the Fuzzzy system are bookmarks, tags and users. Bookmarks are created and tagged by users. By the end of October 2007 Fuzzzy had 221 registered users. Tags are contained in a semantic network created collaboratively by end-users. The mesh of users and the semantic network of tags becomes the folktology (folk + ontology).

Bookmarks can be recommended and saved as favourites. Tag to tag relations and tag-bookmark relations can be voted up or down. Users can find bookmarks by searching, filtering, by browsing the tag-space or by navigating the tripartite bookmark-tag-user page setup.

Fig. 1. Screenshot of a tag page. The current tag is presented in the yellow panel with related tags above, beneath and to the right. The right side of the screen shows a list of bookmarks that are tagged with the current tag.

2.2 System overview

Fuzzzy is an Asp.Net web application running on the Networked Planet TMCore Topic Maps engine. Fuzzzy.com can be used with any modern web browser having JavaScript enabled. It has an experimental web service interface that enables it to act as a tag server and also to connect to other tag servers allowing for distributed global tagging across applications. Fuzzzy is a hybrid Topic Maps solution where the database contains both a topic map and other Fuzzzy specific intermediate data. To simplify the act of creating semantics, a minimalist core tag ontology scheme has been designed. The tag ontology consist of the ‘Tag’ topic type, topic types for specifying either vertical parent, vertical child or horizontal Tag relations and 22 predefined association types each with a role player pair.

Fig. 2. The folktology consist of any words that users choose to tag bookmarks with. All folktology tags and relations are instances of classes that are part of the tag ontology which is constructed from Topic Maps elements.

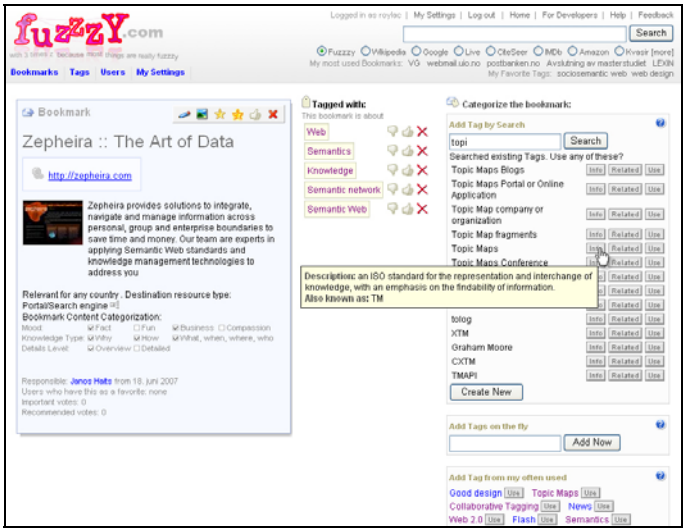

Fig. 3. Screenshot of a bookmark page. The left side shows a bookmark. The middle column shows a list of tags used for the bookmark. The right column shows part of the tagging functionality. The user has entered part of a tag name in the "Add tag by search" text–field. Tags with names or synonyms starting with the entered text are listed.

3 Evaluation and discussion

Our experience with Fuzzzy folktology allows us to point at advantages and disadvantages of this approach, and to suggest guidelines for its further development.

3.1 Comparing folktology to folksonomy

A preliminary study [17] showed an increase from an average of 32 % meaningful relations on 3 typical folksonomy sites to 97 % on Fuzzzy.com where a folktology is used. To evaluate tag relations we have devised a qualitative semantic relevance judgement method similar to that of the Miller and Charles' contextual correlates of semantic similarity experiment [18]. In the Miller and Charles experiment, semantic distance was measured by individuals rating contextual similarity for pairs of nouns. In our study the evaluation is done by articulating a relation between two given tags. If we can not clearly picture a relationship and describe it verbally, we assume that the relationship is either faulty or the semantic distance is to long and should not be presented as a direct related tag. The criteria for a meaningful tag relation are: 1. the related tag must exhibit an appropriate level of specificity. 2. The related tag must be unambiguous and readable. 3. The reader should be able to describe a relation verbally in normal spoken language within 10 seconds. 4. The relation must be intuitively grasped by a reader having basic understanding of the two tags.

Table 1. We have collected a total of 1632 tag pairs, from 4 different social bookmarking sites. Duplicate related tags, synonyms or plural/singular tags have been removed. Only tags with 2 or more relations are used. Only top 10 relations are used.

Bookmarking service	Tagging system	Tag relations evaluated	Meaningful tag relations
del.icio.us	Folksonomy	465	30%
bibSonomy.org	Folksonomy	462	30%
blogmarks.net	Folksonomy	470	37%
fuzzzy.com	Folktology	235	97%

While the tags on Fuzzzy.com have fewer related tags in most cases, the quality of tag relations is significantly higher.

The high number of non-meaningful tag relations in folksonomies can be explained by the way in which users create ambiguous tags and use the pairing of tags in search.

In the evolving Fuzzzy folktology users are encouraged to collaborate to add more appropriate tags and to vote for the best tags for a resource. Folksonomies have no provisions for narrowing terms and the system has a tendency to be dominated by a few frequently used tags. A study by Tonkin [19] showed the unbalanced tag distribution of folksonomies.

Folksonomies have the potential to exacerbate the problems associated with the fuzziness of linguistic and cognitive boundaries [13]. Our folktology reduces this problem by introducing semantics, synonym control and a collaborative environment where users can garden the shared tags, as this term has been used by Jack Park. The tag merging function proved helpful in this regard. Several tag pairs have been merged on Fuzzzy.com. One of these tag pairs was 'Web 2.0' and 'web2'. In folksonomies there is no way to rename a category. The tag is a free text property annotation. In the Fuzzzy folktology the tag is a standalone subject proxy that can be renamed. Synonyms can be added and the tags can be merged. In the merge process from the case above, 'web2' was added to the primary tag's list of synonyms. This has lead to increased consistency and findability. Tag merging in Fuzzzy is currently only available to administrators because the role and trust management module in not fully developed. Tag merging is a critical operation that may affect numerous users as tags are shared throughout the application by all users.

Folksonomies are suitable for serendipitous browsing and discovery of information as they reveal the digital equivalence of "desire lines" [20]. In folksonomies the poor semantics of tags often result in ambiguous but popular information as replacements for relevant information. A resource is indirectly recommended by the many users who save the item. Users often experience the resulting ambiguity as a “nice to have” feature rather than a limitation.

3.2 Unsolved issues in Fuzzzy.com

Information overload. With Topic Maps scopes [21], different contextual viewpoints can be expressed. Since contextual scoping allows for restricting the amount of information which is simultaneously visible, dividing information into specific views reduces the information overload.

In the widest sense of an open social setting such as Flickr, Del.icio.us or Fuzzzy, there is no defined domain of discourse and no precise division of users. In Fuzzzy there is no defined target group. No two persons share identical world views [22]. This leads to a problem of defining scopes because scopes can not be adjusted to the needs the users. A World War II expert will have different needs for scoping on time than a palaeontologist. Most users might be comfortable with scoping content into English, French, German and Spanish while a language expert might need more fine grained language dialect scopes which is redundant to the average user. As with scopes, Topic Maps types cannot be decided for the folktology and therefore no fixed navigation facets or entry points will match the needs of all users.

The folktology of Fuzzzy consists mostly of categories itself represented by tags. All of these tags are candidates for Topic Maps types. Any top-down structuring of the folktology will have deep impacts on further use. When presenting unscoped and untyped information in open folktologies, the danger of information overload becomes apparent as unstructured and different levels of discourse as blended together. Without scopes or any other mechanism to lower the amount of information available at once, the user runs the risk of being overwhelmed by the many new terms that he or she is not familiar with in addition to a vocabulary that may already be contradicting and partially overlapping.

Fuzziness of socio-semantic information. In our socio-semantic application the consensus view is constantly evolving. As culture and language evolve, so does the folktology, and therefore the potential for overlapping, faulty or imprecise information is large. Some information will increase noise, not only because users use different vocabularies, but also because users make both semantic and syntactic mistakes. Casual users cannot be expected to add precise and accurate information.

Low degree of participation. Interviews suggested that the users did not perceive semantic metadata creation through the creation of tag relations as supportive of their personal goals. This is in line with Preece [23], which states that online communities must have a clearly stated goal, which is absent from Fuzzzy. Goal setting helps to gather users who are more in tune with each other and will better function as a whole.

Only a small minority of users created relations between tags. Users did not have the motivation to learn how to do it and they did not see any benefits from doing it.

Users already have a mental representation of the world and have no need to externalize this view by entering their world view into the system.

Users of a bookmarking system require fast submission of bookmarks and fast access to them. Users often prefer to save bookmarks instantaneously without going through the process of adding metadata.

We have observed several cases where users do not agree with tag relations that have been created by others but they take no action to correct it by voting or other means. Users are detached from the folktology and have no interest in seeing to that the folktology evolves into something that supports their views.

Irrelevance. Our usage logs showed that few bookmarks were voted as important. Bookmarks voted as important and displayed on the first page of Fuzzzy were seldom used. Users are most often only interested in bookmarks that are relevant to their specific context and situation or their personal interests and beliefs. The personal views of users on Fuzzzy.com are seldom shared and lists of important links, users and tags have no context and never become interesting for the reader. This increases the amount of irrelevant information, which leads to noise.

4 Towards holistic knowledge creation and interchange

Based on the experience with Fuzzzy, we now outline a proposal for a new information infrastructure, which we feel may lead to solution to some of the persisting problems in Web communication, and bring us closer to realizing the vision of holistic knowledge creation and interchange.

4.1 The need for better informing

The Internet consists of vast amounts of information that can lead to insights and knowledge needed for human and cultural as well as scientific development. Unfortunately, with the current information infrastructures, humans are often unable to locate the relevant sources. Information is in principle available but because it is hard to retrieve, people are willing to sacrifice information quality for accessibility [24].

The anarchistic architecture of the Web has enabled an explosive adoption which we have benefited greatly from. This architecture has now outplayed its role. The now prominent problem of information overload suggests that we need a “top of the mountain”-view of information, an infrastructure that can present ‘the big picture’ and highlight what is most relevant and credible [25].

With Web 2.0, the applications and the growing blogosphere, the Web is becoming participatory. As more and more people publish information, the Internet becomes more and more fragmented, with countless islands of discourse. Only 15% of web pages include links to opposing viewpoints [26].

As the society develops, diversity and complexity are added to the ever growing sea of information and new specialized research areas emerge. This suggests the shift from the present-day reductionistic focus to a concurrent unified and holistic view.

With global and communication-related problems growing in complexity, there is a need for collaborative and democratic systems that can provide relevant and important information with a clear and correct view of the whole [27], and for tools that enable participants to discover truths and induce new knowledge.

4.2 From folksonomies to organic ontologies

We hypothesize that the reluctance to create metadata can be diminished by adapting and focusing the folktology approach to become the tool which knowledge-centric communities can use to create semantics. Without a community there is no discourse, and therefore no shared domain of discourse and no shared semantics.

When we provide tools for evolving knowledge within a knowledge-centric community, both the community and the domain of discourse may be expected to flourish. In these settings the folktology changes from a common universal fuzzy ontology, as it is now on Fuzzzy, to a more specialized organic ontology. When oriented towards a smaller and well-defined community of interest, the user interface can be designed to meet users' needs and reduce cognitive load. Perceived relevance of the folktology will naturally increase with the amount of relevant information. With a smaller community sharing a common goal, purposeful scopes and types can be decided, adding structure and reducing information overload. Fuzziness is easily reduced when users share a relatively consistent vocabulary. Noise is also reduced, because dedicated users are more willing to do gardening work on the semantics.

Ontology creation and evolution is a time-consuming process which requires comprehension, analysis, synthesis and evaluation [28]. Dedicated users are needed for such activities. In a mature community, users will have the incentive to add valuable metadata. Motivation is increased when users feel unique and contributing [29]. Smaller communities have obvious advantage in this regard.

4.3 Holoscopia – Holistic knowledge trough distributed online communities

The Holoscopia platform is conceived as a future system that can help world-wide deployment of Topic Maps-based ontologies. The infrastructure of Holoscopia consists of interconnected Polyscopic Knowledge Bases (PKBs). Each PKB is an autonomous knowledge base for polyscopic structuring [27] of information. The PKB is used by a community to evolve ideas, to develop the consensus about the knowledge within a domain, to decide what information is important, what is the key-point or wisdom that needs to be communicated to the larger community outside, and what actions this insight should lead to. The PKB is a democratic knowledge-creation environment. It has an evolving organic ontology and acts as a portal into the collective community knowledge. It also lets users browse the interconnected web of Holoscopia. Users of a PKB can import knowledge in the form of Topic Maps fragments from other PKB's. Holoscopia provides holism by connecting and aggregating knowledge from diverse communities and letting users explore intricate relations that can infer new knowledge. The PKB can be seen as a combination of a Wiki, bookmarking system, issue tracking, discussion board and hypothesis testing, decision support and concept or dialog mapping tool. The functionality supports mapping and organizing the complex reality, through creation of a multiplicity of simple views. The resulting views can serve as guiding principles and can motivate direction change or orient formal scientific studies. In the most immediate pragmatic sense, the collective wisdom facilitated by Holoscopia can helps us foresee consequences of current trends and help us change course when needed.

Use case scenario for a polyscopic knowledge base. A typical use of the PKB could be within the Topic Maps community. Members might use the system to discuss what areas need more research and why, what aspects of Topic Maps need to be tested in real world applications etc. The system helps users build a line of arguments with supporting resources or previous statements that have been agreed upon. Users build a consensus map of the domain through the organic ontology. The resulting knowledge base can be connected to other domains such as the domains of Natural Language Processing or the Semantic Web. Synergy can be achieved when users view the updated essence of neighbouring domains and get new ideas or find information or knowledgeable members that can help them solve problems in their own domain. Other typical uses for the system are within global social issues such as poverty, globalization, climate change etc. where the problems are complex, broad and fuzzy. With Holoscopia these issues can be investigated by the public.

Social layer. Similar to the Hypertopic model [30], the organization of users and their activities must be facilitated by the system. Coordination of users and their tasks becomes crucial as knowledge is collectively and continuously constructed. For a collective knowledge corpus to thrive, there must be mechanisms for correcting erroneous knowledge and for enhancing and collaborative building based on the existing knowledge. Morville [31] points out that there is a fine line between wisdom of the crowds and ignorance of the mob. This brings us to the question of whether an elite or the crowd is most fit to make collective decisions on behalf of the community. Based on principles of enlightened democracy [32] we propose a democratic election model for online communities. Users who carry out voluntary work receive credits. Users vote on others which they believe are important, knowledgeable or in any way beneficial to the community. The user mass evolves into a community of members with different levels of trust and influentiality. The more trust a user has earned, the more privileges will be granted to him or her. All users have the right to create or import new information. Users with medium trust level can update information added by others. Users on higher levels have permissions to merge and delete. Users at the top level have policing rights and can suspend low level users. All these provisions can, of course, be revised and fine-tuned.

Intermediate knowledge layer. In collective synthesis of knowledge, conceptualizations may need to be modified as new knowledge is gained and the world views of members change. Therefore it is not only the content contained in the PKB that evolves but also the knowledge structure. When an ontology reaches a certain size and complexity, the task of removing outdated parts and adapting valid parts becomes huge [33]. We introduce the notion of organic ontology as a metaphor to describe the user-created evolving ontology. Topic Maps topics are nurtured through their use and trough gardening work. Topics that are not cared for will die. Topic relations grow stronger as they are used. Relations that people find inappropriate will be gardened out by voting. As in Darwinian evolution, the fittest topics and relations survive and gain visibility, while the ones at the bottom of the fitness list (unused, or with negative votes) go extinct. In current implementation of Fuzzzy, the topics and relations are not deleted from the system but are ranked lower in lists and when reaching a lower threshold they will not be visible in normal views. Over time the symbiosis between the community members and the living ontology lowers the effort that is required of the members.

Semantic layer. The semantic layer consist of a Topic Maps engine and holds one topic map instance which reflects the current consensus knowledge based on member input, and is filtered and processed by the intermediate layer. The semantic layer contains mechanisms for knowledge interchange. To allow for both knowledge interchange and evolution, a core ontology is needed. We propose a structure where a user-created ontology is grown on top of a master ontology (Figure 4).

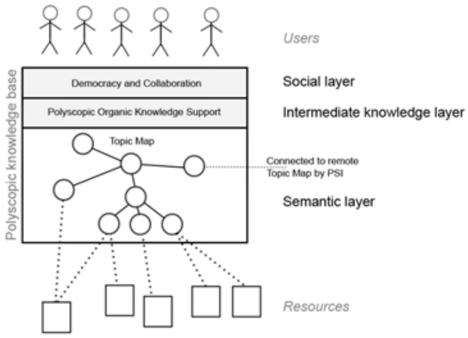

Fig. 4. The three layered architecture of a PKB.

5 Conclusion

We have introduced our Fuzzzy.com platform, which makes it possible for a community of users to co-evolve an ontology in an open online environment, without the need for ontology engineers. The experience with Fuzzzy allowed us to give recommendations for further development of this approach.

Our study has shown that folktology tagging increases the semantic quality of categorization compared to folksonomy tagging. However, folktology tagging is more time-consuming and few users are willing to create semantics in a general social bookmarking system. In a large-scale open socio-semantic system this leads to problems such as information overload, fuzziness, lack of participation and irrelevance of metadata. The process of creating semantics requires dedicated users who share a common goal. We pursue this approach in the Holoscopia platform, which is currently under development. When the folktology is used to facilitate knowledge creation within a specific knowledge-centric community, semantic metadata can evolve as a by-product of dialog and discovery.

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