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 can be realized by connecting distributed knowledge centric communities of dedicated users within specific domains.

1 Introduction

Studies have shown there is an ongoing reluctance among both users and institutions to create metadata [1]. The reluctance towards metadata creation causes the Web to sink into a morass of information overload and become a source of frustration and for many users.

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 still suboptimal compared 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 has proven to be the development and maintenance of ontologies. Several languages now exist for computer mediated ontologies, but the creation and managing of these ontologies is time-consuming, difficult and 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 to 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 relies on flexible and evolving description languages for semantic browsing [10]. S2W emphasizes the importance of humanly created loose semantics as a means to fulfil the vision of the Semantic Web. 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 the two opposite ends of a 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, described in this article, is the result of a semantic adaptation of the folksonomy which we label a 'folktology'.

Our contributions are two-fold. On the one side, we draw insights from the experience with Fuzzzy to discuss the feasibility of folktologies. On the other side, we develop the folktology approach further and show how this approach can be used as a basis for holistic knowledge creation and interchange.

The rest of this paper is organized as follows. Section 2 describes Fuzzzy.com and its folktology. In section 3 we evaluate the ontology-near categorization method of the Fuzzzy folktology by comparing it against folksonomies. We then go on to discuss the unsolved issues of the Fuzzzy folktology, the main of which is the persisting reluctance against metadata creation. In the fourth section we lay out a proposed strategy to tackle these issues.

2 Fuzzzy.com

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.

2.1 System Overview

Fuzzzy is an Asp.Net Ajax web application using 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.

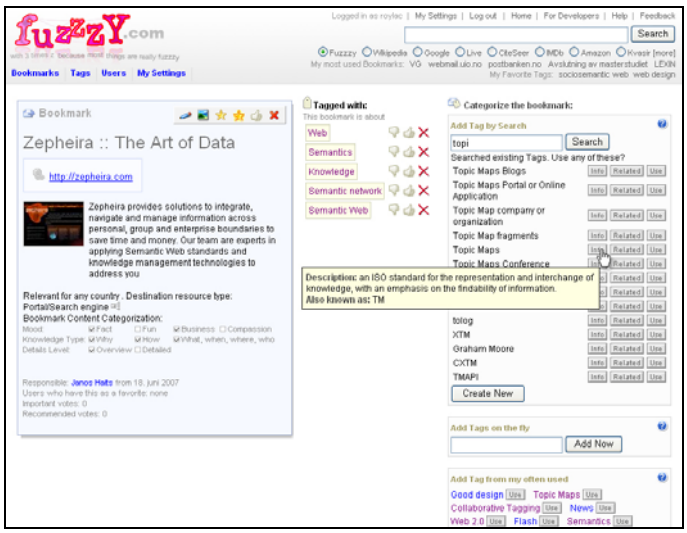

Fig. 3. Screenshot of a bookmark page. The left side shows a bookmark. The middle column shows a list of tags used for the bookmark. The right column shows part of the tagging functionality. The user has entered part of a tag name in the "Add tag by search" text–field. Tags with names or synonyms starting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

3 Evaluation of Semantic Creation in Fuzzzy

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. We now discuss several issues related to this significant difference.

3.1 Comparison of Folktologies and Folksonomies

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 Miller and Charles' contextual correlates of semantic similarity experiment [18]. In 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 specifically describe it verbally we assume 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 given a general

purpose context. 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 and only the top 10 relations are included.

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 tags on Fuzzzy.com have fewer related tags in most cases, the semantic 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 have 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]. The folktology reduces this problem by introducing semantics, synonym control and a collaborative environment where users can garden the shared tags. The Fuzzzy folktology also allow tag merging. Several tag pairs have been merged on Fuzzzy.com. One of these tag pairs was ‘Web 2.0’ and ‘web2’. In folksonomies, categories can not be renamed. 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 tag itself can be merged. In the merge process from the case above, ‘web2’ was added to the primary tag’s list of synonyms. 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 number of users who save the item. Users often experience the resulting ambiguity as a “nice to have” feature rather than a limitation.

3.2 Fuzzzy.com Unsolved Issues

Information Overload. With Topic Maps scopes [21], different contextual view-points 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 these environments there is no defined target group. Also, 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 can not be decided collectively in the folktology making it hard to define a navigational structure. The folktology of Fuzzzy consists mostly of categories or types itself represented by tags. All of these tags are candidates for Topic Maps types, but any top-down structuring by choosing a set of main types in a 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 there is little structure and different levels of discourses are blended. Without scopes the user runs the risk of being overwhelmed by vocabularies that he or she is not comfortable with in addition to vocabularies that may already be contradicting.

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 can not be expected to add precise and accurate information.

Low Degree of Participation. Interviews suggest that users did not perceive semantic metadata creation through the creation of tag relations as supportive of his or her personal goals. This is inline with Preece [23], which states that online communities must have a clearly stated goal.

Goal setting helps to gather users who are more in tune with each other and will better function as a whole. In Fuzzzy there is no community with a common goal to gather around. Creating semantics does neither support collective or personal goals and the core bookmarking purpose is not supported in the most optimal way because the system is designed for semantic creation and collaboration. 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

We now take a wider look at the problems of informing on the Web and propose a new information infrastructure based on the results from Fuzzzy. We argue that the proposed infrastructure can solve problems uncovered with the Fuzzzy socio-semantic folktology and will 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 insight 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 resources. Information is mostly 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 applications and the growing blogosphere the Web is becoming more participatory. As more and more people can publish information, the Internet becomes 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 a need to shift from the present-day reductionist focus to a concurrent unified and holistic view. With the problems of growing complexity, information overload and the anarchistic Web we argue that 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 [25], 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 the folktology approach to become tools for semantic metadata creation in knowledge-centric communities.

In order to develop the folktology approach we first provide an analysis of the issues uncovered in the Fuzzzy folktology. Without a defined domain of discourse any information can be entered into the system increasing irrelevant information and the amount of noise for users. Few users share a sense responsibility to the metadata or the information content, and therefore users will not take the time to garden the information space. Irrelevant and large amounts of information along with noise cause a reduced user experience which results in few users adopting the system. This bootstrapping problem is also a result of design that is not aligned with the needs of the users. In Fuzzzy the creation of semantics is shadowed by the primary purpose of adding and retrieving bookmarks. Without no purpose and immediate benefits directly associated with the creation of semantics, few users will spend time on this activity. Without a community there is no discourse and therefore no domain of discourse (ontology) can develop.

By providing tools that can help to evolve knowledge within knowledge centric communities, both the community and the domain of discourse will be able to flourish. In these socio-semantic settings the folktology changes from a common universal fuzzy ontology, to specialized organic ontologies. When oriented towards smaller well defined communities of interest, the user interface can be designed to meet users' needs, reducing cognitive load and increasing information relevance. With a smaller community sharing a common goal, purposeful scopes and types can be decided, adding structure and reducing information overload by contextualization. Fuzziness is reduced when users share a relatively consistent vocabulary. Noise is 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 incentives 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 ontologies which is seen to be essential for the growth of the Semantic Web [30].

The infrastructure of Holoscopia consists of interconnected Polyscopic Knowledge Bases (PKB). 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 a consensus about the knowledge within a domain, to decide what information is important, what are the key-points 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 let 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 provide holism by connecting and aggregating knowledge from the 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, forum and hypothesis testing, decision support and concept mapping tool. The functionality supports mapping, organizing and discovering the complexity of reality. The resulting wisdom of a PKB can serve as guiding principles for motivating direction change or encourage formal scientific studies. In a utilitarian sense, the collective wisdom facilitated by Holoscopia can help us to foresee consequences and thus leveraging the long-term common good.

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 needs to be tested in real world applications etc. The system helps users to systematically 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 to 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 problem is complex, broad and fuzzy. With Holoscopia these issues can be investigated by the public.

Social Layer. Similar to the HyperTopic model [31], 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 collaboratively evolving the existing knowledge. Morville [32] points out 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 [33] 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.

Intermediate Knowledge Layer. In our application of collective knowledge synthesis, 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 [34]. We introduce the notion of organic ontology as a metaphor to describe the user-created evolving ontology.

In the organic ontology, 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 others that are unused, or with negative votes go extinct. In the current version of Fuzzzy, unpopular tag relations are ranked lower in lists and when reaching a lower threshold they will not be visible in default views.

The symbiosis between the community members and the living ontology lowers the effort that is required of the members and also decrease information overload.

Semantic Layer. The semantic layer consists of a Topic Maps engine and holds one topic map instance. The topic map reflects the current consensus knowledge, based on member input, filtered and processed by the intermediate layer.

The semantic layer contains mechanisms for machine readable knowledge interchange and interoperability. To allow for both knowledge interchange and evolution, a core ontology is needed. Similar to figure 2 we propose a user created ontology on top of a master ontology using he Topic Maps constraints language.

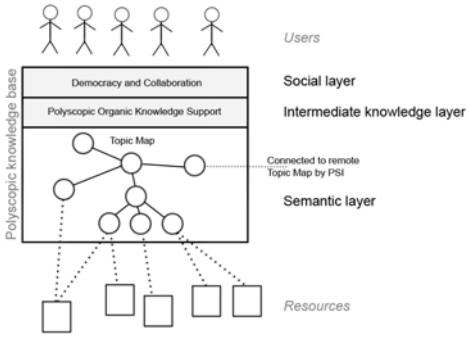

Fig. 4. The three layered architecture of a PKB.

5 Conclusion

We have seen that collaborative approaches to simple ontology-near evolution are possible in open online environments without dedicated resources such as ontology engineers. The Socio-semantic Web approach can be used to create semantics organically from a relatively small core without a single authority.

Demonstrated by Fuzzzy.com, the Topic Maps based folktology enables sharing of tags between applications across the Web.

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 application.

The problems of large scale open and common socio-semantic systems can be summarized by; information overload, fuzziness, low participation and a large amount of irrelevant information. The ongoing development of the Holoscopia platform aims to solve these issues. We argue that, by providing the appropriate tools and infrastructure to accommodate knowledge centric communities, semantic metadata can grow as a by-product of dialog and discovery on a global scale.

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