The State of the Art in Tag Ontologies: A Semantic Model for Tagging and Folksonomies

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Abstract

There is a growing interest on how we represent and share tagging data for the purpose of collaborative tagging systems. Conventional tags are not naturally suited for collaborative processes. Being free-text keywords, they are exposed to linguistic variations like case (upper vs lower), grammatical number (singular vs. plural) as well as human typing errors. Additionally, tags depend on the personal views of the world by individual users, and are not normalized for synonymy, morphology or any other mapping. The bottom line of the problem is that tags have no semantics whatsoever. Moreover, even if a user gives some semantics to a tag while using or viewing it, this meaning is not automatically shared with computers since it's not defined in a machine-readable way. With tagging systems increasing in popularity each day, the evolution of this technology is hindered by this problem, since tagging metadata is not readily generated and shared. In this paper we discuss approaches to represent collaborative tagging activities at a semantic level, and present conceptual models for collaborative tagging activities and folksonomies. We present criteria for the comparison of existing tag ontologies and discuss their strengths and weaknesses in relation to these criteria.

Keywords: tag; tagging; tagging ontology; folksonomy; semantic tagging, etc.

1. Introduction

Wikipedia (http://www.wikipedia.com) defines a *Tag* as a 'free-text keyword' and *Tagging* as an 'indexing process for assigning tags to resources'. A *Folksonomy* is described as a shared collection of tags used on a certain platform. The term folksonomy defines a user-generated and distributed classification system, emerging through bottom-up consensus (Vander Wal, 2004). Folksonomies became popular on the Web with social software applications such as social bookmarking, photo sharing and weblogs. A number of social tagging sites such as del.icio.us, Flickr (http://www.flickr.com), YouTube (http://www.youtube.com), CiteULike (http://www.citeulike.org) have become popular.

Commonly cited advantages of folksonomies are their flexibility, rapid adaptability, free-for-all collaborative customisation and their serendipity (Mathes, 2004). People can in general use any term as a tag without exactly understanding the meaning of the terms they choose. The power of folksonomies stands in the aggregation of tagged information that one is interested in. This improves social serendipity by enabling social connections and by providing social search and navigation (Quintarelli, 2005).

The simplicity and ease of use of tagging however, lead to problems with current folksonomy systems (Mathes, 2004). The problems can be classified in two:

- *Local variations*: Tags have little semantics and many variations. Thus, even if a tagging activity can be considered as the user's cognitive process, the resulting set of tags does not always correctly and consistently represent the user's mental model.
- *Distributed variations*: Most tagging systems have their own specific ways of working with and interpreting the meaning of tags. Thus if we want to aggregate tagging data

from different applications or services, it's very difficult to find out the meanings and correlations between a sets of tags.

These limitations are due to the lack of a uniform format which can represent the structure and semantics of tagging activities. In this paper, we will compare existing conceptualizations of tagging activities and folksonomies, to assess their merits and thus contribute to future work in this area. Such a conceptualization, or ontology, is intended to be used in the representation of tagging data in collaborative tagging systems. We start by discussing the reasons why we need Semantic Web technologies for tagging communities. We then briefly overview existing conceptual models for tagging and propose a novel model for folksonomies. We continue by introducing existing tag ontologies and compare them using our conceptual model. Finally, we discuss the results, draw conclusions and provide suggestions for future research.

2. Folksonomies: Why Semantic Web Technologies?

2.1 Tagging and Folksonomies

There have been a significant number of efforts to add more structure and semantics to conventional tagging practices. Approaches to tagging and folksonomies have been dominated by a focus on the (statistical) analysis of tag usage patterns (Golder and Herberman, 2006), information retrieval and navigation (Halpin et al., 2006; Jäschke, 2008) and social network analysis and clustering (Mika, 2005; Brooks et al., 2006) based on tagging data. Golder and Herbermann (2005) collect del.icio.us data and analyse structure and usage patterns of tagging systems. They discuss the distinction between collaborative tagging and taxonomies - although collaborative tagging has many limitations in terms of semantics and structures, it provides the opportunity to learn from one another through sharing and organizing information. Marlow (2006) showed that for certain users, the number of tags can become stable over time, while for others, it keeps growing. Cattuto et. al (2007) observes small world effects by analyzing a network structure of folksonomies from Bibsonomy (http://www.bibsonomy.org) and del.icio.us. He introduces the notions of clustering and characteristic path length to describe the small world effects. According to his study, folksonomies exhibit a small world structure and have a sort of social network. Mika (2005) carries out a study to construct community-based semantics based on a tripartite model of actors, concepts, and instances. He emphasizes the social context for a representation of ontologies and generates the well-known co-occurrence network of ontology learning as well as a novel semantic network based on community relationships using del.icio.us data.

2.2 Semantic Web based Approaches

Currently, there are a number of debates on the merits of folksonomies with respect to traditional classifications. Despite conflicting differences between folksonomies and ontologies (Shirky, 2005; Hendler, 2007), the Semantic Web technologies can be seen as a complement to folksonomies. As free-text keywords, tags do not have an exact meaning and succumb to linguistic ambiguities and variations including the human error factor. While a user may give some semantics to a tag through using or reading it, computers cannot automatically interpret the meaning, since it is not defined in a machine-readable way (Passant, 2008). Folksonomy systems make no allowance for a uniform way to share, exchange, and reuse tagging data among users or communities (Kim et al., 2007). With the use of tagging systems in constant increase, these limitations will become evermore critical. Some propose the integration of folksonomies and ontologies to enrich tag semantics (Specia and Motta, 2007). In particular, Gruber (2007) and Spivack (2005) emphasize the need for folksonomies and ontologies to work together. In general tag ontologies contribute to the following three points:

1. *Knowledge Representation Sophistication*: A tag ontology can robustly represent entities and relationships that shape tagging activities, explicitly stating the knowledge structure

of tagging data and facilitating the Linked Data (Berners-Lee, 2006) of tagging data on the Web.

2. *Facilitation of Knowledge Exchange*: Ontologies enable knowledge exchange among different users and applications by providing reusable constructs. Thus a tag ontology can be shared and used for separate tagging activities on different platforms.
3. *Machine-processable*. Ontologies and Semantic Web technologies in general (knowledge representation, processing and reasoning) expose human knowledge to machines in order to perform automatic data linking and integration of tagging data.

3. Conceptualizing Tagging and Folksonomies

Before providing a detailed comparison, we start by reviewing individual conceptual models of tagging activities that preceded our own. A tagging model needs to distinguish between entities in a tagging activity that need to be represented, and address the relationships that exist between them. After reviewing existing tagging models we discuss whether the proposed models are suitable to represent collaborative tagging activities. We then propose our extended model, which caters for the collaborative aspect of folksonomies.

3.1. A Model for Tagging Activities

Many researchers (Mika, 2005; Halpin, 2006; Cattuto, 2007) suggested a tripartite model of tagging activities. Although different interpretations of tagging are used by different authors, they have a common ground and are based on three entities - users, tags, and resources. These form a triple that represents the Tagging Process:

Tagging: (*U*, *T*, *R*) -- (1)

where *U* is the set of users who participate in a tagging activity, *T* is the set of available tags and *R* is the set of resources being tagged. Gruber (2005) suggested an extension to model (1):

Tagging: (*object*, *tag*, *tagger*, *source*, + or -) ------------------------ (2)

where *object*, *tag*, and *tagger* correspond to *R*, *T*, and *U* in the tripartite model respectively. The *source* refers to the tag space where the tagger applies the set of tags whereas the positive/negative parameter is an attempt to represent the collaborative filtering of 'bad' tags from spammers. This tagging model was successful in representing the tagging process at a semantic level. In fact, most tag ontologies have a Tagging class, based on Gruber's model, as a core concept.

3.2. A Model for Collaborative Tagging Activities

Existing approaches consider a tagging activity as one where an individual user assigns a set of tags to a resource. Whereas they provide effective ways to describe the process of tagging, existing models do not really support collective tagging activities. We therefore want to provide a *Folksonomy Model* to represent this knowledge, where the folksonomy is considered as a collection of instances of the tagging model. Before doing so we need to clarify the differences between simple (individual) and folksonomy-based tagging practices. Folksonomies are not created independently by individuals in isolation, but collectively by people who participate in the collaborative tagging activity. Thus, the folksonomy model has to cover all the collaborative aspects and relationships in addition to the objects associated with tagging activities. A straightforward model for a Folksonomy could look like this:

Folksonomy: (*tag set*, *user group*, *source*, *occurrence*) --------------------- (3)

where the tag set is the set of all tags being employed, the user group is a set of users who participate in the tagging activity and the source is the location where the folksonomy is utilized (e.g. social web sites, online communities). The fourth parameter, occurrence, plays an important role to identify the tags' popularity. Comparing this model to the tagging model (2), one can outline some similarities. The resources (objects) do not form part of the Folksonomy model per se. Rather, the Folksonomy is applied to the collective tagging process of the resources. The tag and tagger parameters in (2) have been replaced with a collective representation of these entities – tag set and user group. The source is still unique since a folksonomy is a multi-user approach to tagging on a single platform. We are of the opinion that filtering should not be represented at this level. Alternatively, given we represent multiple tags in this model, the frequencies of individual tags become important and thus we include the occurrence as our fifth parameter.

Contrary to the concept of Tagging, a folksonomy is a method rather than a process in itself. It can be considered as the practice of acquiring knowledge from collaborative tagging processes. What this means in practice is that the Folksonomy model should include a representation of the collective tagging processes performed by the group of users. We reflect this in (4) by extending (3) to make the individual tagging activities (to which single users contribute) explicit:

Folksonomy: (*tag set, user group, source, occurrence, Tagging†*) ---------------- (4)

where the last parameter reflects the collective tagging processes performed by the users of the folksonomy, where an individual tagging process is represented by:

Tagging: (*object, tag, tagger*) -- (5)

where object, tag and tagger have the same semantics as those in (2). Thus our Folksonomy model (4) now incorporates a representation for the collective tagging processes which are individually defined by the Tagging model (5).

4. Overview and Comparison of Tag Ontologies

There is no golden criterion for the comparison of tag ontologies. For this reason, we confine ourselves to a brief discussion comparing the tag ontologies with respect to their suitability for:

(a) representing tagging activities and tagging data
(b) representing folksonomical features

We will compare seven conceptualizations, keeping in mind the folksonomy model (4) we proposed in Section 3.2. In particular we include in our comparison a conceptualization that we presented in earlier work – the SCOT Ontology (Kim et al., 2008). The choice of the conceptualizations was based on how concrete the model is for tagging and use by online communities. Although a lot of work in analysing folksonomies has been done in social theory and information retrieval, very few tag ontologies have been reported until today. Few researchers have explicitly specified conceptualization of tagging data (Borwankar, 2005; Story, 2007) in a formal language. As far as our list is concerned, at the time of this research only 6 of the 7 conceptualizations were actually proposed as ontologies and described in a dedicated representation language (e.g. OWL). Although Gruber's model is just defined conceptually, we include it in our comparison since many research papers have cited his model and some ontologies have been developed by way of this model. The selection of ontologies included for comparison (plus Gruber's conceptualization) is shown in Table 1. Some of the selected conceptualizations are more suited to the first criterion set out in the start of this section (a), whereas others are more suited for the second (b). However, all conceptualizations are suitable for both criterions to varying degrees. We will now have a brief look at them individually.

Ontology	URL	Namespace	Format	Update	Applications
Gruber	-	-	-	-	-
Newman	http://www.holygoat.co.uk/projects/tags/	*tags:	OWL	Nov 2005	http://Reyvu.com
Knerr	http://code.google.com/p/tagont/	*tagont:	OWL	Jan 2007	-
Echarte	http://eslomas.com/tagontology-1.owl	*ec:	OWL	2007	-
SCOT	http://scot-project.org	scot:	OWL	June 2008	http://int.ere.st http://relaxseo.com http://openlinksw.com
MOAT	http://moat-project.org	moat:	OWL	Feb 2008	http://openlinksw.com lord.info
NAO	http://www.semanticdesktop.org/ontologies/nao/	nao:	NRL	Aug 2007	Nepomuk

Table 1. Features of Tag Ontologies. * *Defined for use in this paper*

Gruber's work is considered an early attempt to conceptualize tagging activities. His model can be considered as a first step towards a general applicable representation model for tagging. Although his model itself is not an ontology it clearly reveals a generic conceptualization of tagging. For more details on his work we refer to Gruber (2007, 2008). Newman's model (referred to as Newman) describes relationships between an agent, an arbitrary resource, and one or more tags. In this model there are three core concepts such as Tagger, Tagging, and Tag to represent a tagging activity. Knerr (2006) provides the tagging concept in the Tagging Ontology (referred to as Knerr) and Echarte et. al (2007) propose a model for folksonomies (referred to as Echarte). Since their approaches are based on the ideas of Gruber and Newman, the core elements of the ontologies are almost identical. In particular, Echarte's model extends concepts such as time, domain, visibility, type, etc., and is represented by OWL. The SCOT Ontology - Social semantic Cloud of Tags, describes the structure and semantics of tagging data and enables social interoperability of tag data among heterogeneous sources. Although SCOT's main goal is to represent collaborative tagging activities, it is also suitable to represent folksonomical features (e.g. source, user group, frequencies, tag co-occurrence, etc.). MOAT (Passant, 2008) - Meaning of a Tag, is intended for semantic-annotation of content by providing a meaning for free-text tagging. In addition to extensions to the Tag, Tagging, and Tagger concepts from Newman's ontology, MOAT provides the Meaning class to represent custom, user-provided 'meanings' for tags. The Nepomuk Annotation Ontology (NAO) (Scerri et. al, 2007) is provided for annotating resources on the Social Semantic Desktop (http://www/nepomuk.semanticdesktop.org/). It is not entirely dedicated to tagging practices but nevertheless demonstrates the increasing importance of tagging representation on social systems.

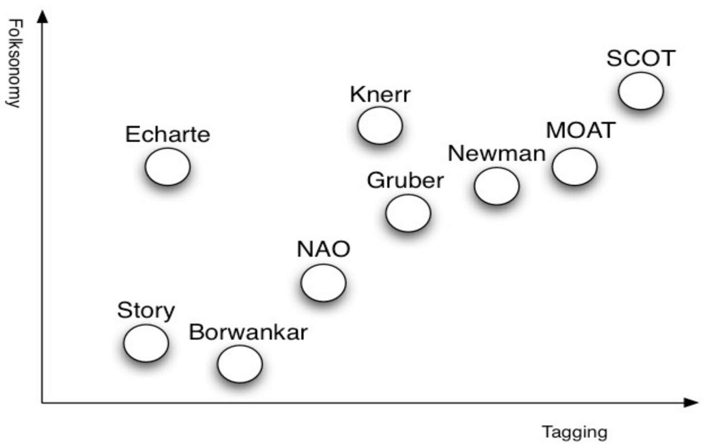

Figure 1 : Criterion suitability for different conceptualizations

Figure 1 demonstrates the different inclinations of the seven conceptualizations in Table 1 given the criteria set out in the start of this section. Whereas Newman's Ontology is more inclined towards representing tagging data, and Echarte's Ontology towards representing folksonomical features, SCOT has a higher level of sophistication in both directions. In the next section we will be having a close look at the entities and features that the six ontologies and Gruber's model are able to represent. We will support our conclusions in this section by exploring the suitability of the individual conceptualizations vis-à-vis criterion (a) and (b) set out in the start of this section. We start by listing and comparing the concepts (classes) and proceed by listing and comparing their features (attributes).

4.1. Class Comparison

In this section we support the general reported comparison we presented in the previous section. First we will have a look whether the individual conceptualizations are suitable for representing general tagging activities and tagging data. All models have a representation for the o*bject*, *tag* and *tagger* in our Tagging model (5) and all except NAO have a concept representing the tagging process. In Newman's model, the tagging concept is further refined into *tags:RestrictedTagging* (exactly one tag for a resource) and *tags:Tagging* (one or more tags for a resource). Echarte et al. provides the *Annotation* class to represent the tagging activity – i.e. it is the same as *tags:Tagging*. Thus, the *Tagging* concept can be considered as a core concept of tag ontologies. Although SCOT and MOAT have different goals compared to others, they also can describe tagging by linking to the tags:Tagging class in Newman's ontology.

Model	Resource	Tag	Tagging	Tag Set	User	User Group	Source	Others
Gruber	*Object*	*Tag*	*Tagging*		*Tagger*		*Source*	*Polarity*
Newman	rdfs:Resource	:Tag	:Tagging		foaf:Agent			:RestrictedTagging
Knerr	rdfs:Resource	:Tag	:Tagging		:Tagger	foaf:Group	:Service Domain	:VisibilityEnum
Echarte	:Resource	:Tag	:Annotation		:User		:Source	:Polarity
SCOT	sioc:Item	:Tag	tags:Tagging	:TagCloud	sioc:User	sioc:Usergroup	sioc:Site	:Cooccurrence
MOAT	rdfs:Resource	tags:Tag	tags:Tagging		foaf:Agent			:Meaning
NAO	rdfs:Resource	:Tag			:Party			

Table 2: Ontology Concepts. Concepts are locally defined unless otherwise stated (e.g. rdfs:Resource)

We now consider whether the ontologies address collective tagging data and provide for folksonomical features, especially with regards to our Folksonomy Model (5). Some ontologies which are based on Gruber's model (which was not designed for folksonomies) have been extended in order to support folksonomies. For instance, Knerr and Echarte have the *ServiceDomain* and the *Source* class to represent the *source*. In addition, Knerr allows a user to use *foaf:Group* alongside *foaf:Person* to describe the *user group*. Similarly, NAO allows the user to use nao:Party to represent the *user group*. MOAT does not have a class for defining it. Nevertheless they are not enough to represent folksonomies at a semantic level. SCOT is consistent with the folksonomy model and provides representations for the *source*, u*ser group* and *tag set*. In Table 2 we provide the list and comparison of classes provided by these conceptualizations that are relevant to our study. Additionally we must note that although an ontology might not provide all the required representations, they can be connected to external vocabularies such as SIOC (Semantically-Interlinked Online Community), FOAF (Friend-of-a-Friend), SKOS (Simple Knowledge Organization System), or DC (Dublin Core Metadata) to further weave data on the Web. For example, MOAT and SCOT makes thorough use of the SIOC ontology to describe online communities. Unfortunately, some ontologies do not consider this possibility. In particular, although Echarte has its own classes to represent the tagging and Folksonomy concepts, these classes do not have any relations with other RDF vocabularies.

	Literal	*Time*	*Numeric Values*
Source	Tagont:hasServiceName		
Resource	ec:hasURI ec:hasSourceName		
User	ec:hasUserName		
Tag Set	dc:title dc:description	scot:updated	scot:totalTags scot:totalTagFrequency scot:totalItems scot:totalCooccurTags scot:totalCooccurFrequency
Tag	tags:name tags:tagName tagont:prefTagLabel tagont:hasTagLabel nao:prefSymbol nao:prefLabel nao:description ec:hasPrefLabel ec:hasLabel ec:hasAltLabel ec:hasHiddenLabel	scot:lastUsed nao:created nao:lastModified	scot:ownAFrequency scot:ownRFrequency scot:cooccurAFrequency scot:cooccurRFrequency ec:hasPosition
Tagging	Tagont:hasNote	tags:taggedOn tagont:isTaggedOn ec:hasDateTime	

Table 3 Date Type Properties. The table shows value attributes for some core concepts, interpreted as domain (row) – property – range (column).

4.2. Attribute Comparison

While the number of classes enhances taxonomical representations, the power of ontologies lies in the ability of representing relationships between the classes. Although most of the studied ontologies have a similar taxonomical structure, their attributes vary according to their goals and purposes. We will now have a look at the attributes provided by the ontologies, and compare their functionalities. We differ between data type attributes - which relate classes to non-conceptual data (e.g. string or date); and object type properties which provide relationships between classes.

Data Type. Aside from declarative features which represent relationships among users, tags, and resources, a semantic model for folksonomies needs to provide for descriptive features that state non-conceptual values. Most surveyed tag ontologies have many attributes to describe data-type values, i.e. numerical quantities, free-text descriptions, date, time, etc. The data-type properties relevant to this work are summarized in Table 3. A number of datatype properties are either directly or indirectly (i.e. via subclassing) reused from the Dublin Core vocabulary. For instance Newman's ontology *tags:name* is a subproperty of *dc:title* and *tags:taggedOn* is a subproperty of *dc:date*. Only SCOT provides for the description of numerical values for entities, e.g. *scot:totalTags* (attributed to a *scot:TagCloud*) refers to the total number of tags in a tag cloud and *scot:totalItems* refers to the total number of resources tagged with tags in the tag cloud. SCOT also provides properties relating to the frequency of a tag itself. Whereas the simplistic *scot:ownAFrequency* refers to the actual occurrence(s) of a particular tag in a tag cloud, *scot:ownRFrequency* represents the percentage frequency of a tag within a particular tag cloud, relative to the total of all tag frequencies in that tag cloud. There are many attributes to describe specific string and literal values, such as *tags:name*, *tagont:prefTagLabel*, *nao:preLabel*, and *ec:hasLabel* for providing a tag's name.

	Source	*Resource*	*User Group*	*User*	*Tag Set*	*Tag*	*Tagging*	*Others*
Source								tagont: hasServiceHomepage ec:hasSource
Resource						tags:taggedWithTag scot:hasTag nao:hasTag	tags:tag	
User Group							tagont:hasTagging	
User							tagont:hasTagging	
Tag Set	scot:tagSpace		scot:hasUsergroup	scot:createdBy	scot:composedOf	scot:contains	scot:taggingActivity	
Tag		tags: isTagOf scot:tagOf nao:isTagFor ec:hasRelatedResource		scot:usedBy nao:creator	scot:containedIn	tags:equivalentTag tags:relatedTag scot:aggregatedTag scot:spellingVariant scot:delimited tagont:sameTag ec:hasTag		moat:hasMeaning ec:hasPolarity scot:cooccursIn scot:cooccursWith
Tagging	tagont: hasServiceDomain ec:hasSource	tags:taggedResource tagont:hasTaggedResource ec:hasResource moat:tagMeaning		tags: taggedBy tagont:hasTagger ec:hasUser		tags:associatedTag tagont:hasTag ec:hasAnnotationTag		tagont:hasType tagont:hasVisibility

Table 4. Object Type Properties. The table shows relationships between core concepts, interpreted as domain (row) – property – range (column)

Object Type. The object type properties relevant to our study for the surveyed ontologies are summarized in Table 4. SCOT, Echarte and Knerr provide the possibility to define a tagging activity. In SCOT, there is no local property to describe who is involved in a tagging activity. For this purpose SCOT reuses Newman's *tags:taggedBy* attribute. Via SCOT one can describe who uses tags via the *scot:usedBy* property. Meanwhile, three ontologies have the property to identify a location or source in which the tagging occurred. TagOnt provides *tagont:hasServiceDomain* to link the tagging activity to the *ServiceDomain*, Echarte provides *ec:hasSource* with the *Source* as its range value, whereas SCOT provides *scot:tagspace* with a range of *sioc:Site*. The relation between tags and resources is defined via *tags:isTagOf* (range: *rdfs:Resource*), *nao:isTagFor* (range: *rdfs:Resource*), and *scot:tagOf* (range: *sioc:Item*) properties in the Newman, NAO and SCOT ontologies respectively. They also provide inverse properties for this relation. Defining relations between tags is one of the benefits of using an ontology to model folksonomies, since this effectively enriches the semantics of a tag set. Nevertheless only SCOT and Newman take advantage of this possibility. Whereas Newman provides very restricted properties such as *tags:equivalentTag* and *tags:relatedTag*, SCOT provides many more attributes such as *scot:spellingVariant* and *scot:delimited*. The spelling variant property is further refined into *scot:acronym*, *scot:plural*, *scot:singular* and *scot:synonym*. In addition, the latter has further subproperties to define specific synonym types, i.e. *scot:hypenatated*, *scot:underscored*, *scot:slashed*, and *scot:spaced*. In comparison to other ontologies, SCOT specifically provides attributes that represent folksonomical characteristics such as *scot:hasUsergroup*, *scot:createdBy*, *scot:contains*, and *scot:taggingActivity*.

To conclude this section we briefly give a summary of the comparison. So far, tag ontologies have mainly been used for representation of tagging activities and to a lesser extent, for folksonomical features. We believe that SCOT is the most suitable for the Folksonomy model given in Section 3.2. However one might argue that the surveyed ontologies have different ontological purposes and different expressivity. A practical solution is to enrich knowledge representation of collaborative tagging activities and folksonomies by interlinking ontological features of some of the given ontologies.

5. Conclusion

In the first half of this paper we propose a model for collaborative tagging activities and folksonomies – based on the widely accepted model for tagging. The detailed comparisons presented in Section 4 can be used to conclude some general observations about ontologies related to tagging activities and their usefulness in collaborative tagging systems. As such, this research can be considered as a first attempt to systematically compare different conceptualizations of semantic tagging for collaborative tagging systems. We believe that tag ontologies should be evaluated with respect to a particular goal, application or scenario rather than merely for the sake of an evaluation. Our observations take into consideration two separate criteria – the representation depth of tagging data per se, and representation of the collaborative aspect in folksonomies. As we mentioned in the start of the paper, tag ontologies are in an early stage and existing approaches need to be elaborated or combined in order to enrich their schema in order to meet both criteria. Nevertheless the surveyed ontologies already offer an enhancement for collaborative tagging systems – especially given the machine-processable representations that they can provide.

Following the comparison of the tag ontologies we arrived at the following conclusions:

- There is agreement on the issue as to what are the most elementary building blocks of a model for the tagging. The building blocks consist of the taggers, the tags themselves, and the resources being tagged.
- Different individuals created substantially different conceptualizations of tagging data and tagging activities despite the fact that their purposes are similar.
- Most tagging conceptualisations do not cover the overall characteristics of folksonomies. Adopting concepts from Gruber's model and the Newman vocabulary, SCOT is the most suitable ontology for representing collaborative tagging activities. It provides the most appropriate representations for the Folksonomy model we defined in (4). In addition, interlinking SCOT with MOAT further increases the expressivity of knowledge representation, enabling richer metadata for tagging activities and folksonomies.

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