

# Tagging Ontology – Towards a Common Ontology for Folksonomies

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## Abstract

*Collaborative tagging represents the process by which many users describe resources (e.g. web pages or photos) with free-form keywords (tags). The combination of all users tags for a certain resource reflects the common understanding of that resource from the users' point of view, which is called "folksonomy".*

*Today there are many systems making use of folksonomies, most notably del.icio.us and flickr. These systems (also referred to as "social software") allow the users to publish their taggings for the benefit of the community, mostly via RSS feeds. The problem is, that there is no common agreement about the semantics of a tagging, and thus every system uses a different representation, hindering interoperability between systems and the automated processing by software agents. In this paper we use Semantic Web technologies to develop an ontology for folksonomies, making interoperability and automated processing feasible. In order to validate our ontology we extract sample tagging data from del.icio.us and feed it into our ontology. Finally, we run some SPARQL queries against this data to prove that the folksonomic information can easily be accessed within our ontology.*

## 1. INTRODUCTION

In today's internet, many new applications arise in the context of the so-called "Web 2.0", a term popularized by O'Reilly Media [1]. Web 2.0 emphasizes the collaboration of users and the sharing of information amongst them (thus the term "social software"). In this paper we concentrate on folksonomies, which are an integral part of the Web 2.0.

Another emerging technology is the Semantic Web [2], an initiative led by the W3C Consortium<sup>1</sup> and Tim Berners-Lee, which aims to make the web machine-processable by underlaying it's contents with a semantic model [3].

In the remainder of this section we disambiguate the terms folksonomy, taxonomy and ontology, before we

discuss the problem that there is no uniform and formally defined semantics for the concept of a "tagging", which we want to solve with this work.

In section two we describe related efforts of formalizing the semantics of a "tagging" with Semantic Web technologies and relate them to our approach.

In section three we take a look at some popular social software applications and discuss how they currently represent the concept of "tagging". We also present our vision of future folksonomy systems and the benefits of using a common tagging ontology.

Our own approach for a common tagging ontology is detailed in section three. We review our design and provide a proof-of-concept application to validate our approach.

Finally we discuss our results and provide an outlook for further research.

### 1.1. Folksonomies, Taxonomies and Ontologies

A *taxonomy* is a classification scheme with a hierarchical structure. A typical and often cited [4][5] example for a taxonomy is the Dewey Decimal System<sup>2</sup>, which is used by librarians to classify books according to a fixed categorization scheme and organize them into shelves. In the digital world, typical examples are the Yahoo! directory<sup>3</sup> or the dmoz open directory project<sup>4</sup>. Both of them provide a directory of web resources organized in a fixed set of categories.

In contrast, a *folksonomy* arises from the free-form annotation of web resources, done by it's users, and without the constraints of a predefined taxonomy [6]. The distribution of tags for each resource yields a "stable pattern" [5], which means that – given a critical mass of taggers – there will be a few tags for each resource that are most prominent and used by most of the users to describe that particular resource, and thus represent the common understanding of the resource from

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<sup>2</sup> <http://www.oclc.org/dewey/>

<sup>3</sup> <http://dir.yahoo.com/>

<sup>4</sup> <http://dmoz.org/>

<sup>1</sup> <http://www.w3.org/2001/sw/>

a user's point of view, which Tom Gruber calls "distributed human intelligence" [7]. The term folksonomy is combination of "folk" and "taxonomy", originally defined by Thomas Vander Wal [8]:

"Folksonomy is the result of personal free tagging of information and objects (anything with a URL) for one's own retrieval [sic]. The tagging is done in a social environment (shared and open to others). The act of tagging is done by the person consuming the information."

Whilst a taxonomy is "hierarchical and exclusive", a folksonomy is "non-hierarchical and inclusive" [5].

The term "ontology" has its roots in philosophy and means the study of being or existence. However, in the field of knowledge management and artificial intelligence, ontology is "an explicit and formal specification of a conceptualization" [9]. This definition is valid in the context of the Semantic Web (where RDFS and OWL are means to build an ontology) and is used throughout the rest of this paper.

## 1.2. Motivation for a Tagging Ontology

As part of the Web 2.0 movement, many online applications provide the ability to tag resources and to publish or share these "taggings" with other users of the system (thus the term "social software"). However, in current folksonomy systems there is no semantic and no formal agreement on the representation of such a tagging. This means that every system uses a different format to publish its tagging data, which prevents interoperability and does not allow for machine-processability.

In this paper we present an OWL ontology which describes the concept of a "tagging". Thus we describe the formal representation as well as the semantics of a tagging. In an ideal world all of the folksonomy systems would agree on the same representation, leading to interoperability between the systems and leveraging new possibilities, which will be discussed later in this paper.

## 2. RELATED WORK

There are only very few approaches that try to formalize the concept of a tagging. Wu [6] points out that a tagging consists of the basic quadruple

(user, resource, tag, time)

which they use as the basis to derive emergent semantics from user generated social annotations (i.e. taggings). They do not provide an ontology, but all of the following approaches build upon the same quadruple.

Newman [10] is the only one to provide an ontology in OWL for the concept of tagging. Although his approach has been discussed on the W3C semantic-web

mailing list<sup>5</sup>, it has not found widespread application. According to his website it is being actually used in one software project, which he could not further disclose in a personal conversation [11]. Nevertheless, his ontology is very clean and kept simplistic. In his ontology, a **Tagging** "reifies the n-ary relationship between a tagger, a tag, a resource, and a date". Another notable point is the inclusion of the Simple Knowledge Organisation System (SKOS) vocabulary [12], which allows to semantically relate a tag with another tag (narrower term, broader term).

Although not providing an ontology, Gruber [7] informally describes some concepts that should be included in a tagging ontology. His ideas resemble the aforementioned quadruple. He does not consider the time of a tagging in his writing, but he introduces a new dimension to the tuple: The *source* of a tagging, which specifies the notion of a community. This allows to differentiate between tagging data from different systems and is the basis for "collaborative tagging across multiple applications". Another issue he addresses is "negative tagging", which allows to vote against a certain tag. Also, he states that one tag can have multiple identities (e.g. different languages or spellings) but denotes the same concept.

The Annotea project<sup>6</sup> from the W3C should also be noted. Even though it does not provide an ontology describing the concept of a tagging, it defines an RDF Schema for bookmarking and annotating resources [13], which is a similar concept.

The approaches described above were the only ones that use (or at least plan to use) Semantic Web technologies, more specifically, OWL. Apart from those, the microformats<sup>7</sup> rel-tag [14] and xFolk [15] specifications provide a different approach: Instead of using RDF(S) or OWL, they simply defined additional attributes which can be embedded in any XHTML web page. This relatively simple technique "designed for humans first and machines second" explains why rel-tag and xFolk are already integrated in some folksonomy systems. Though its ease-of-use, it is by far not as powerful as the previously described approaches using Semantic Web technologies.

## 3. CURRENT LANDSCAPE OF FOLKSONOMY SYSTEMS

Today there are many systems which allow the unrestricted tagging of web resources. The most prominent examples in this space are del.icio.us<sup>8</sup> and flickr<sup>9</sup>, both owned by Yahoo!. The proof that tagging sys-

5 <http://lists.w3.org/Archives/Public/semantic-web/2005Mar/0154.html>

6 <http://www.w3.org/2001/Annotea/>

7 <http://microformats.org>

8 <http://del.icio.us>

9 <http://www.flickr.com>

tems work and under what circumstances they work best have been provided elsewhere [16][5]. Next we provide some examples of tagging systems and highlight the problem of the non-uniform representation of taggings across these systems.

### 3.1. Examples of Social Software

Del.icio.us is a social bookmarking system, which allows any registered user to store their bookmarks online, share them with the public and assign tags to them. Whenever a user bookmarks a page, the responsive, AJAX<sup>10</sup>-driven user interface facilitates the process: it autocompletes tags while-you-type (based on tags you previously used) and recommends the most popular tags given to that resource by other users. Thus the user can either apply his own tags, imitate the popular tags, or both – it finally contributes to the “power law” and “stable pattern” of tags we mentioned before [5][6].

Flickr is an online photo-sharing application, which allows registered users to store and share their photos online. Users can tag their own as well as their friends’ photos. It is possible to browse by user, by tag, by groups of users, themes or tag clusters. Photos can also be commented or viewed as a slide show. Besides del.icio.us and flickr, there are many other “social applications” leveraging folksonomies: Technorati<sup>11</sup> uses a tagging infrastructure to describe weblog posts, CiteULike<sup>12</sup> and Connotea<sup>13</sup> use tags to annotate academic references, Last.fm<sup>14</sup> lets you share and tag music and upcoming.org<sup>15</sup> shows events added and annotated by it’s users. For an in-depth review of different social bookmarking applications see [17].

### 3.2. The Problem of Representing Tags

The publicly shared information of these applications (e.g. a certain user’s bookmarks) is made available in a machine-readable format, mostly by means of RSS (Really Simple Syndication). RSS is an XML-based format for content syndication in the World Wide Web [18]. Although RSS is a widely adopted standard, it was not intended to carry information about tags, and therefore each service developed it’s own format to represent a tagged resource.

Apart from the semantic problems (see also [10]) when using RSS to represent taggings, there are other problems due to different versions which are not backwards-compatible. For example, RSS 1.0

(RDF Site Summary) is a valid RDF document, while RSS 0.91 (Rich Site Summary) and RSS 2.0 (Really Simple Syndication) are plain XML documents not semantically interpretable within the Semantic Web.

### 3.3. Proposed Solution

In our envisioned scenario each user has all of his taggings in one place, independently from the folksonomy systems he uses. Figure 1 shows the architecture of current folksonomy systems by the example of flickr and del.icio.us. The folksonomy systems store the user’s profile and tagging data on their own servers. Some of the data (e.g. the users latest taggings) is published via RSS, but (as already discussed) in a non-interoperable format with no semantical agreement on how to represent a tagging.

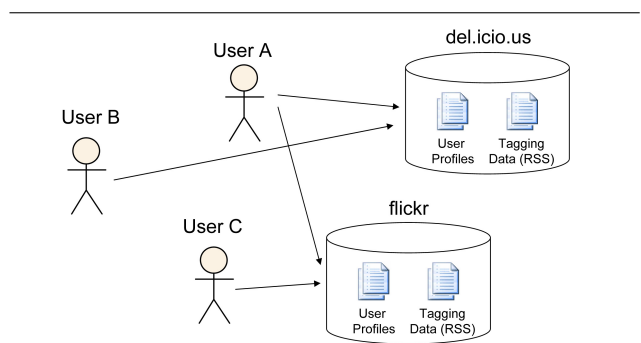


Figure 1. Folksonomy systems today

Our envisioned architecture (see figure 2) makes use of Semantic Web technologies such as Friend of a Friend (FOAF) [19] to represent the users profile (along with relations to other people) and to keep all of the users tagging data in one place (`tags.rdf`) and compliant to a commonly agreed upon specification, which we aim to provide with our tagging ontology.

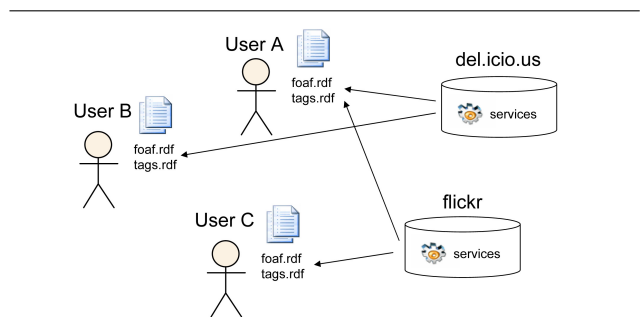


Figure 2. Envisioned architecture

In the envisioned scenario above the folksonomy applications concentrate on providing services (such as

10 Asynchronous Javascript and XML (AJAX), a technology to update parts of a web page without the need for a complete page reload

11 <http://www.technorati.com>

12 <http://www.citeulike.org>

13 <http://www.connotea.org>

14 <http://last.fm>

15 <http://upcoming.org>

the creation of image galleries in the case of flickr), whilst the users have full control over their tagging data. Along with a commonly agreed standard for representing taggings (such as FOAF is for representing persons and their relations) it would enable many benefits, among others:

- Interoperability through a standardized (but extensible) format
- Cross-application tagging
- Using “pools of tags” for a set of related folksonomy systems
- Narrowing down the folksonomic view to your friends, co-workers

We aim to provide the foundation for this envisioned scenario by creating an ontology which describes the formal specification for the concept of tagging. Following the style of FOAF the recommended filename for the tagging data is `tags.rdf`.

## 4. IMPLEMENTATION OF THE TAGGING ONTOLOGY

In this section we first describe the knowledge-engineering methodology we used for the development. Next we discuss the basic design and some “design patterns” we used. Finally we validate our ontology by creating a sample `tags.rdf` file and executing some SPARQL queries against it in order to prove that the envisioned scenario is viable.

### 4.1. Approach

Even though we knew that our ontology will be relatively small, we decided to follow a knowledge-engineering methodology [20], which consists of the following steps:

1. Determine domain and scope
2. Consider reusing existing ontologies
3. Enumerate terms in the ontology
4. Define classes and hierarchy
5. Define properties
6. Refine properties
7. Create instances

The domain and scope of our ontology was pretty clear from the beginning: We wanted to create an ontology which describes the concept of tagging. It should make folksonomy systems interoperable and provide for additional benefits as discussed in the previous section.

Regarding the reuse of ontologies, we used subclassing of existing, commonly used ontologies where possible (e.g. the property `isTaggedOn` is a subclass of `dcterms:created`). Since the only existing ontology

describing the concept of tagging [10] is hardly ever being used, there is no added value in extending it.

In order to find the relevant terms in our ontology we started with paper and pencil to find the basic terms and interrelations, then we used mindmaps to substantiate our drafts with the envisioned scenario in mind. Steps 4–6 are covered in greater detail in the next section, the creation of instances was part of our evaluation phase as described in section 4.3.

### 4.2. Ontology Design

In this section we describe the design of our ontology. Figure 3 shows a simplified overview of our tagging ontology. Relations to external ontologies (such as `isTaggedOn` is a subclass of `dcterms:created`) and cardinality restrictions (such as a `Tagging` has at least one `Tag`, exactly one `Tagger` and exactly one tagged `Resource`) have been omitted in the figure for better readability.

The central Element of the ontology is a `Tagging`, which can be seen as a tuple of

(time, user, domain, visibility, tag,  
resource, type)

where only the above mentioned properties are obligatory by means of a cardinality constraint.

The `isTaggedOn` property specifies the date and time of the tagging. Making it a subclass of the `dcterms:created` property makes sense: Consider an application which does not know our ontology; even if it does not know the meaning of `isTaggedOn`, it still can infer that something was created at the given time (assuming that it knows the `dcterms`<sup>16</sup> ontology). Thus the reuse of existing, commonly used ontologies where applicable is generally considered a good thing.

The `hasTagger` property relates a user with a tagging. Figure 3 shows that we used “necessary and sufficient conditions” to make `Tagger` a “Defined Class” [21]. It basically means that any `rdfs:Resource`, which is either a `foaf:Person` or a `foaf:Group` and has at least one related `Tagging` can also be inferred to be a `Tagger`.

The `ServiceDomain` class specifies the folksonomy system (such as `del.icio.us` or `flickr`) in whose context the tagging happened. This would allow to convert tagging data from existing applications without losing its original context. It also allows for “cross-application tagging”: For example you could specify that all tags used within the `ServiceDomain A,B,E` should be handled as one “tag pool” (thus reducing the number of overlapping tags), while the tags used within `ServiceDomain C` and `D` should be handled separately. A `ServiceDomain` also has a service name and homepage

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16 <http://dublincore.org/documents/dcmi-terms/>



able, e.g. via Protg's ontology library<sup>17</sup> or the Ontolingua library<sup>18</sup>.

Further research has to be conducted regarding the performance of the SPARQL queries in a real-world scenario. Also, the adoption of our ontology is a critical factor, as the usefulness of reusing an ontologies scales up with the ontologies' spreading and acceptance.

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<sup>17</sup> <http://protege.stanford.edu/plugins/owl/owl-library/>

<sup>18</sup> <http://www.ksl.stanford.edu/software/ontolingua/>