

XETA: EXTENSIBLE METADATA SYSTEM

For Extensibility, Accuracy, Suitability and Convenience

Yejin Kim, SukBong Lee, SungJun Lee and SangGyoo Sim
Software Laboratoeis, Corporate Technology Operations, Samsung Electronics Co., LTD
416, Maetan-3Dong, Yeongtong-Gu, Suwon-City, 443-742, Republic of Korea

Keywords: Metadata, ontology, semantic web, adaptive user interface.

Abstract: This paper presents an eXtensible mETAdata system (XETA system) which makes it possible for the end-user to organize and extend the structure of metadata. We discuss four requirements of the flexible metadata system in semantic web and a methodology to implement the requirements. Using the XETA system, the end-user can flexibly extend metadata, enhance its semantic accuracy and selectively apply the metadata in context. The main purpose of XETA system provides end-users with a way to construct metadata in bottom-up, not force them to accept fixed form and fixed meanings for metadata.

1 MOTIVATIONS

Metadata are data about data to describe resources in purposes of identification, discovery, assessment, management and so on. The emergence of semantic web has expected more powerful metadata systems.

There are many related works for metadata system. Traditionally, fix structured metadata allows the user to annotate with plain text according to a template structure, such as Dublin Core (DMCI, 2007). This approach has an advantage to provide accurate and systemic information for resources, but it has disadvantages not to allow the end-user to freely organize the structure of metadata, and there is no way to satisfy all area and all users, even though it has some extensibility.

Tag-based annotation method allows the end-user to freely arrange keywords to describe resources. This approach has unlimited extensibility but not systemic structure. Therefore, it has a limit to recognize the relationship of keywords and to understand a keyword in semantic. To solve the problem, a concept model was proposed to implement semantic of tags for Tag Ontology (Yang and Ishizuka, 2007). Ontology-based semantic annotation is one of the major techniques for putting machine understandable data, which are semantically interlinked metadata and there were some discussions about the requirements one has to meet when developing a component-based, ontology-driven annotation framework (Handschuh,

Staab and Maedche, 2001). These approaches provide a method to enhance semantic accuracy of metadata but not a method to efficiently extend metadata for end-users. However, they might be used to interlink tags as a backend process of our proposed extensible metadata model.

The Resource Description Framework (RDF) is a language for representing information about resources, particularly intended for representing metadata about Web resources (Hayes, 2004). RDF precisely identifies the relationships that exist between the linked items, however, it does not inform the end-user of a way to organize and extend metadata intuitively.

Ontology is a formal, explicit specification of a shared conceptualization of a domain of interest (Gruber, 1993). The concept and realization of ontology has been more important in semantic web. The concept of ontology includes an upper level ontology and a number of domain ontology. In practice, it is very difficult to construct the upper level ontology across all domains. Though possible to construct it, it is expensive and concerned about whether general end-users conveniently use many concepts defined in the ontology. The SUMO ontology (Niles and Pease, 2001) contains almost 1000 concepts and most of them are unintuitive, which makes them unusable for browsing. The fundamental problem is the approach to ontology which forces end-users to accept the fixed meanings system by top-down. Terminology is like an

organism, which newly come into being, change and disappear. Fixed ontology is a closed space not to evolve by itself, which cannot allow end-users to participate in organizing the meanings system based on their consensus.

2 REQUIREMENTS

As more easily generating and acquiring enormous amount of contents, the end-user has had to manage much more contents. Recently the end-users have become “prosumers” so that they have assumed the responsibility to provide not only contents but also adequate metadata for their contents, because it needs well-organized metadata for contents to acquire attention among a large number of contents in the web.

The proposed system focuses on organizing metadata system by end-users in a local domain. It reaches from an empty meanings space to a well-organized metadata space with consensus based on collaboration.

Based on above motivations, the requirements of the proposed metadata system are the followings;

- Extensibility: users can extend metadata at any point of metadata individually or collaboratively.
- Accuracy: metadata should be interpreted as users intend.
- Suitability: users can determine whether they open a part of metadata or not according to their purposes.
- Convenience: users can easily and reasonably organize and extend metadata.

2.1 Extensibility

The fixed metadata system allows the end-user to annotate with text according to a fixed template structure, such as Dublin Core. This approach has a bit of possibility to extend metadata but the end-user cannot freely organize own structure of metadata. The problem is that many areas of contents have newly emerged and the areas have been also subdivided in more detail. Even contents service providers have had difficulty designing metadata systems suitable for all contents areas. It takes high cost to acquire the domain specific knowledge and to satisfy diverse demands of users for metadata. Moreover, at present the end-user has a greater limit to describe metadata for his contents than the commercial contents providers.

No one knows in advance which form of metadata should be assumed in evolving areas. The fields of contents have been broad and variable so that the metadata system with fixed form has been not inefficient. Therefore the metadata system for Web2.0 generation should take an extensibility to design the structure of metadata according to the end-user's immediate needs in broad and variable fields. Such extensibility should be also available not only by an individual but also by collaborative intelligence.

2.2 Accuracy

In semantic web, one considerable to search proper contents in accordance with the user's intention is that we should insert accurate metadata to contents prior to develop semantic search engines. It needs the method to grant “meanings” to metadata because simply to arrange keywords or tags lacks information in semantic point of view. Many unclear explained contents often fail to arrest attention in the web. Some keywords may be multivocals, or a series of keywords may have ambiguous relationships among them. For example, “cats” may be a kind of pet or a title of musical. “Silver” may be a kind of colour or a sort of metal. In case of combining two words, “silver cat” may mean a living cat with silver hair or a silver accessory with the shape of cat.

2.3 Suitability

Prosumers have both responsibility and rights to open adequate metadata for their contents. Even same contents need different metadata in different context. For example, about a flower picture taken by a digital camera, flower websites and digital camera websites require different information. People connecting to flower websites may want to get the information about species, habitat, colour or blooming season of the flower. In other hands, people connecting to digital camera websites may want to get the information about body model, lens, functions or configurations of the digital camera. It means that the user should write different metadata whenever uploading contents to diverse websites. One solution to this problem is that the user configures metadata for the purpose. While sharing contents, the configuration of metadata is maintained and the metadata is self-filtered in context. For implementing this function, each fields of metadata should be possible to set an option for the specific domain opening and be either individually handled or freely combined.

2.4 Convenience

A well-designed metadata system should consider the convenience of users. Although the proposed metadata system makes it possible for an end-user to extend metadata accurately and suitably, the metadata system would be disregarded if it is difficult for common users to use the system. Therefore, it needs a user interface which guides users to the right direction and helps them to construct proper metadata more conveniently.

3 METADATA SYSTEM

This section describes the proposed metadata system to meet the four requirements presented in section 2.

3.1 Architecture

Figure 1 illustrates the functional architecture of the proposed extensible metadata system. A user device includes the following components to support the extensible metadata system:

- Media Manager: managing metadata and negotiating content policies with Policy Negotiator
- Media container: consisting of contents and its extensible metadata.
- Policy Negotiator: filtering information according to users preferences
- Policies Repository: storing policies of content, device, privacy and so on
- Communication Module: communicating with external devices or networks

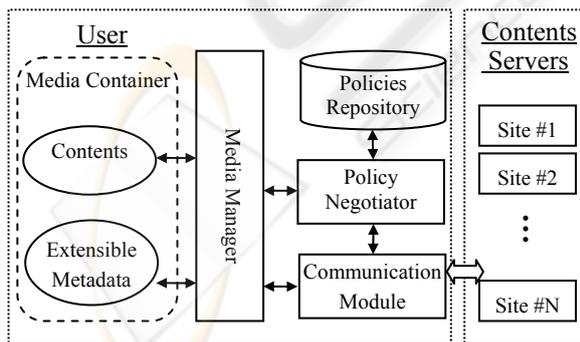


Figure 1: Functional Architecture of the Proposed Metadata System.

Media Manager controls to generate and update metadata. The generated or updated metadata is stored with the corresponding contents in Media

Container. When the user transfers a media to external devices or networks, Media Manager calls Policy Negotiator to filter metadata. Policy Negotiator makes a merged policy based on comparison of the metadata configuration of content and the content policy from Policies Repository. According to the merged policy, Media Manger transfers the media with appropriate metadata through Communication Module to Contents Servers.

3.2 Tag Object

The proposed metadata system considers metadata as a tag set. The tags should support the functions of extensibility, accuracy and suitability. In the proposed system, a tag is managed as an object, not a character string, to implement such functional tags. Tag Object is an object which contains attributes and functions to implement meanings of metadata. Tag Object classifies standard tag and extended tag. Standard tags construct a basic metadata structure defined by service providers or applications, which are recommended to have general and minimal categories. Or it means the Tag Object determined by consensus of domain users. Extended tags construct a user defined metadata structure, which extends standard tags and makes them detail. It means the Tag Object entered by the end-user to add some meanings to the domain metadata system. Tag Object has attributes such as view or element. View tag represents view, category, purpose and role in order to clear the concept and usage of a tag whereas element tag represent information explaining contents (see Table 1). View tag and element tag implement ontological concept and instance.

We introduce a simple method to design Tag Object but not give a full detail of that in this paper. The Single Tag Object Method showed at Table 2 is to implement a Tag Object containing a tag with single meanings. This method has an advantage to make multiple tags freely connected and reused. To provide more powerful functions, it could combine more than two Single Tag Objects. A Single Tag Object contains the following fields: ID, attribute, classification, function and reserved field. Function field can define diverse functions to manage metadata. For example, a function to connect Tag Objects based on the relationship of tags can compute and store rates between the Tag Object and other Tag Objects.

Table 1: Classification and Attributes of Tags.

| Classification | Attribute | Description |
|---------------------|-----------|---|
| Standard Tag Object | View | View, category, purpose and role to expatiate element tag, provided by applications |
| | Element | Keywords to explain contents, provided by applications |
| Extended Tag Object | View | View, category, purpose and role to expatiate element tag, defined by users |
| | Element | Keywords to explain contents, defined by users |

Table 2: Single Tag Object Method.

| Component | Description |
|----------------|----------------------------------|
| ID | character string |
| attribute | [view element] |
| classification | [standard extension] |
| function | function for metadata management |
| reserved | reserved for application |

3.3 Collaborative Metadata

The proposed metadata system supports the extensibility of metadata structure not only for an individual user but also for collaborative user group. Content servers include websites to which a user device uploads contents. A content server has policies related to contents and accepts only appropriate contents through negotiation with the user device. The uploaded contents may contain the extended metadata what is called a user-defined metadata. The content server can extract a metadata structure from the user-defined metadata, and adopt it as a candidate metadata structure for its specific domain. The adopted metadata structure can be reused by other users in the website. Also, another user can make a more elaborate metadata structure based on the candidate. That is, it is possible for the metadata system to be efficiently enhanced by collaboration in social networks. How to evaluate and adopt the user defined metadata structure is out of scope of this paper.

3.4 Example

This clause describes the functional flow of an example to extend metadata. It assumes that John has a multimedia device supporting the proposed metadata system. John generates a movie about

animal cats and writes metadata of the movie. For example, “authorship” and “content” fields could be provided as the basic metadata structure. He enters an element tag [John] in “authorship” field and an element tag [cats] in the subject field of content information. “Authorship,” “content” and “subject” is classified to view tags which describe to which categories [John] and [cats] belong.

John thinks that the standard element tag [cats] does not sufficiently represent the subject of his movie because it is possible for other users to confuse his contents with the musical Cats (see Figure 2). To clear the meanings of [cats], He decides to extend metadata for [cats]. He can extend metadata using two kinds of tags, i.e. element tag and view tag. He enters an extended element tag [animal] as additional information of [cats]. Figure 3 shows an example to extend metadata of his contents about cats. Other users explicitly consider his movie as contents related animal cats not the musical Cats. However other users still do not know which kind of cats means the [cats].

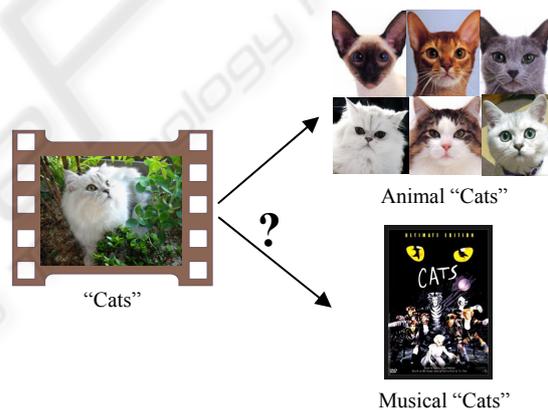


Figure 2: Ambiguity of Tag Cats.

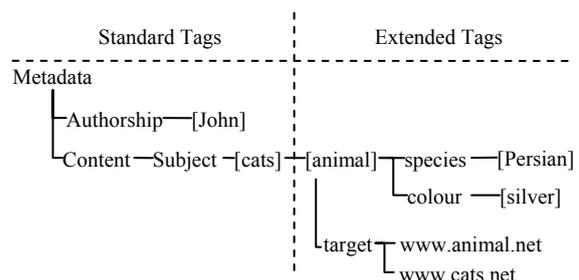


Figure 3: Example of Extending Tag Objects about Cats.

John decides to provide “species” and “colour” as more information about his cats. He enters an

extended element tag [Persian] for the extended view tag “species” and an extended element tag [silver] for the extended view tag “colour”. At this point, other users can imagine more concrete image of the cats in the movie made by John.

John thinks that the detail information of cats such as species and colour are meaningful only in the specific domains like cat community or animal website. He does not want to impose useless information on other users, who do not need these detail information of cats. So John configures metadata to open the detail information only to two target websites, “http://www.animal.net” and “http://www.cats.net.” Users could get the species and colour information of the cats only if they search his movie from the two target websites, but they could not in the other web sites.

In connection with privacy, John wants to guarantee anonymous authorship about his contents uploaded in public networks so that he configures his content policy that the authorship of his contents is hidden when he transfers his contents to public networks. Even though his personal information is written in the metadata of his contents, the personal information would be filtered according to the content policy when the movie is transferred to any public network.

3.5 Relational Tag Bridge

The proposed model provides the functionality for extensibility, accuracy and suitability, whereas it entrusts an end-user with the delicate work to realize the ontology about metadata. It is difficult that the end-user to construct well-organized metadata structure if he is not an expert of the domain. To enhance the end-user’s convenience, it should support a user interface in a proper time recommending appropriate tags used in the domain. For this, we propose the concept of Relational Tag Bridge which makes an end-user possible to easily and reasonably construct and extend own metadata structure. Relational Tag Bridge is a kind of graph consisting of tags and rates among the tags. It is a method to manage metadata database in domain server and also an adaptive user interface to provide accessibility to proper tags for end-users.

The key of Relational Tag Bridge is the rating method to evaluate the relevance of tags. Rates are flexibly determined and updated by users. Each rate among tags is increased whenever a user enters a series of tags for the contents. That is, the tags simultaneously selected by many users could be considered as the tags having meaningful

relationship in the domain so that such tags would have high rates; the tags would be recommended to other users if the rate is more than any critical value. To prevent dominated tags from being everlasting, the user may see the wider range of tags related the focused tag by decreasing the critical value in his local metadata system. Or he may check recent candidates to apply more diverse tags related the focused tag.

At the example of Figure 2, it is supposed that John does not know which tags are appropriate for his contents to provide rich metadata. John enters the tag “cats” however he does not know that the tag “cats” induces what kind of ambiguity. At this time, the Relational Tag Bridge can inform the user of possible categories related to the entered tag “cats”: “pet,” “animal,” “species,” “musical,” and “CF” (see Figure 4). He selects “animal” so that “species” and “Chordate” are recommended as the detailed views. If he selects “species,” he can obtain more information about species of cat. Finally, he selects “Persian” and terminates to input metadata for his contents. Based on the selected tag history, “Persian” means Persian cat but not Persian person; “cats” has very low relevance with Persian person at this time. At any point, John can determine whether to extend his metadata or not.

An advantage of Relational Tag Bridge is that it effectively guides the user to express what he wants to explain. According to selection of the user, the focused tag and its related tags are dynamically changed and consist of a focused view in each point of time. The focused view effectively delivers the necessary amount of information to the user. Relational Tag Bridge also has an effect on inflow and spread of new knowledge in a domain. That is, users can get new knowledge about their interests by contacting new terminology or categories through the focused view. Another advantage of Relational Tag Bridge is to construct the structure of huge amount metadata through collaboration based on folksonomy. Such approach helps for contents or service providers to reduce the cost of constructing metadata structure in which all users’ requirements are reflected in a specific domain.

Its limitation is that it costs a great deal to maintain and manage rates among all tags. An alternative for this problem is to restrict the number of relative tags and to periodically update rates but not real time. The method of rate update is out of scope in this paper.

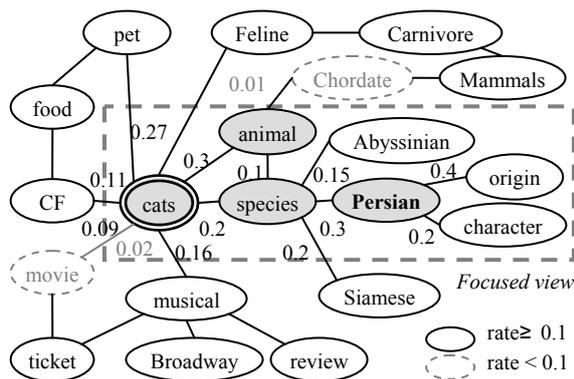


Figure 4: Example of Relational Tag Bridge.

4 DISCUSSIONS

The main purpose of this paper tries to find a way to organize a flexible and intuitive metadata system which is not to design an ontology system containing fixed concepts for a domain. We considered the suggested four requirements: extensibility, accuracy, suitability and convenience. As showed in above example, (a) the user can freely extend metadata using extended tags, (b) the meanings of each tag becomes made clear using view tags which explains the element tag in specific view, (c) the user has a right to control metadata by adopting or rejecting the metadata in context and (d) the user can conveniently reuse common tags refined by collective intelligence in the domain.

As the user organizes metadata, the organized tags could be interlinked using the attributes and functions of Tag Object. This concept is different from the models to automatically extract and interlink data from the resource, which generally has low quality. The proposed model helps the user to interlink metadata in semantic. The method to model Tag Objects, i.e. the Single Tag Object Method, is a kind of backend process to efficiently manage the extended metadata. Such backend process might be substituted several ontology models mentioned in introduction.

The link of Tag Objects is not static, but dynamic and statistical in semantic; it is a bottom-up and folksonomy approach by end-users. The different point of view tag from the existing ontological category is that view tags freely connect or disconnect each other, and must not be necessary for every element tags. Tag Objects are more intuitively connected according to user's needs rather than systemically. The metadata system by an individual might be vulnerable but the collaborative metadata

system could evolve to the most necessary form for the domain.

5 CONCLUSIONS

We presented a concept model of extensible metadata system, the XETA system in this paper. The XETA system can implement intuitive and flexible metadata structure by making and connecting Tag Objects. It provides a method for end-users to easily extend metadata using Relational Tag Bridge. We hope a new approach to construct metadata system by bottom-up in the web.

The future works for the XETA system are the followings:

- How to design effective Tag Object
- How to evaluate quality of metadata structure defined by users
- How to manage candidate metadata structure in side of contents servers.

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