Ontology-Based Meta-Framework for Metadata Interoperability

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Abstract

In the current information environment where various types of resources coexist with heterogeneous formats of metadata standards, efforts have been made to achieve metadata interoperability in order to utilize multiple metadata standards and to (re)use existing metadata records by developing strategies, ranging from simple element mapping to complex structural modeling. These efforts have generated several different approaches to minimizing difference between heterogeneous standards and maximizing consistency across them, including element mapping, crosswalk, application profile, and metadata registry (Chan & Zeng, 2006). Each approach has its unique strengths; nonetheless, each is limited in its ability to achieve reliable metadata interoperability. The limitations involved in metadata interoperability are mainly due to the heterogeneity of standards which stems from semantic, syntactical, and structural differences between standards (Veltman, 2001).

To make standards fully interoperable, it is necessary to understand the semantics of each standard reflected in the components of the standard such as element, syntax, and structure. However, most of the current approaches to metadata interoperability have focused on the representational meanings of elements in establishing element relationships, resulting in the identification of ambiguous, misleading, or inaccurate relationships. Without understanding the semantics, metadata interoperability may be merely a superficial mapping of the labels of metadata elements.

To address these problems in metadata interoperability, this research focuses on the critical dimension of heterogeneity that leads us to different semantic levels of relationships: element, syntax, and structure. In representing these complex relationships, this research proposes a conceptual framework that mediates semantic, syntactical, and structural differences across heterogeneous standards. This framework functions as an external structure that systematically organizes components of standards, demonstrates component relationships, and reflects the framework of each standard. For these reasons, this conceptual framework may function as a relative metadata framework about frameworks of existing standards, that is, a meta-framework.

Meta-framework is built from myriad existing efforts. It is mainly inspired by application profile where metadata elements drawn from one or more standards are combined and optimized to be used in particular context (Heery & Patel, 2000). Although application profile is enough to provide semantics of different standards, it has failed to make them interoperable and to represent semantic relationships between them.

To complement this weakness, meta-framework consists of three parts: metadata vocabulary, concept vocabulary, and concept profile. Metadata vocabulary functions as storage of a set of elements extracted from different standards with the consideration of structural and syntactical differences. The extracted elements are categorized based on their semantic similarities, which provides semantic categories of elements. Through these categories, metadata vocabulary also functions as semantic vocabulary of metadata elements. Once metadata vocabulary is created, relationships between semantically related elements need to be established in order to make them interoperable. This process can be accomplished by identifying the basic unit of meaning that each element has. Ontology is applied to identify these units, convert them into concepts, and construct concept vocabulary. Concept is considered as a generalized and context-independent

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surrogate of an element. The concept is not changed even if the element of the concept is represented in a different format. By converting the meaning of an element to this concept, the semantic ambiguity resulting from different context of each standard can be removed. Thus, concept vocabulary can be used to clarify specific meaning of each element and to mediate semantic differences between elements through identifying concepts from them.

Concept profile is based on metadata vocabulary and concept vocabulary. It functions as a specification of concepts that specifies the meaning of a set of concepts and provides information about how each concept is functionally tied to other concepts. It also functions as an assemblage of concepts by clarifying the semantic relations between concepts and how to combine the functions of concepts into a single framework. Although this concept profile is constructed based on the elements from existing standards, it exists independently of any particular element used in any standard. Thus, this profile provides a context for using concepts in a generalized way that can be consistently applied to the establishment of any element relationship.

Meta-framework is constructed based on these three applications. When implementing, these applications describe substantial resources and have values from the resources. In this sense, meta-framework consists of four components: concept, element, function of the element, and element value. Each component is a key to the implementation of meta-framework and functions as a node that is connected to other nodes with specific relationships. The nodes are connected to each other and establish pairs that constitute the architecture of meta-framework: concept-value pair bridged by element and concept-element pair specified by the function of each element. Each of these pairs is considered a statement of a relationship established to clarify the semantics of each standard. Through these pairs, equivocal meaning of an element can be clarified and indicate value that is exactly matched to the concept and the element.

Meta-framework provides an alternate view that metadata interoperability is achieved in a generalized and standardized way of representing the semantics of components in different standards. In meta-framework, the different contexts are mediated in a context-independent framework. It allows metadata elements originated in one context to be used in another context with minimal loss of meaning and semantics. It also provides the capability of conceptually combining semantic, syntactic, and structural interoperability into a single framework. With these advantages, meta-framework is expected to provide a context-independent and consistent way of achieving or improving metadata interoperability that can function as a conceptual framework to encompass all the current metadata standards.

References

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