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IEEE Standard for Learning Object Metadata

IEEE Computer Society

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Abstract: A conceptual data schema that defines the structure of metadata for a learning object is specified in this standard.

Keywords: learning object, learning object metadata (LOM), metadata, reuse

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Introduction

(This introduction is not part of IEEE Std 1484.12.1-2002, IEEE Standard for Learning Object Metadata.)

Metadata is information about an object, be it physical or digital. As the number of objects grows exponentially and our needs for learning expand equally dramatically, the lack of information or metadata about objects places a critical and fundamental constraint on our ability to discover, manage, and use objects.

This standard addresses this problem by defining a structure for interoperable descriptions of learning objects.

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IEEE Standard for Learning Object Metadata

1. Overview

1.1 Scope

This is a multi-part standard that specifies learning object metadata. This part specifies a conceptual data schema that defines the structure of a metadata instance for a learning object. For this standard, a learning object is defined as any entity—digital or non-digital—that may be used for learning, education, or training.

For this standard, a metadata instance for a learning object describes relevant characteristics of the learning object to which it applies. Such characteristics may be grouped in general, life cycle, meta-metadata, educational, technical, educational, rights, relation, annotation, and classification categories.

The conceptual data schema specified in this part permits linguistic diversity of both learning objects and the metadata instances that describe them.

This conceptual data schema specifies the data elements which compose a metadata instance for a learning object.

This part is intended to be referenced by other standards that define the implementation descriptions of the data schema so that a metadata instance for a learning object can be used by a learning technology system to manage, locate, evaluate, or exchange learning objects.

This part of this standard does not define how a learning technology system represents or uses a metadata instance for a learning object.

1.2 Purpose

The purpose of this multi-part standard is to facilitate search, evaluation, acquisition, and use of learning objects, for instance by learners or instructors or automated software processes. This multi-part standard also facilitates the sharing and exchange of learning objects, by enabling the development of catalogs and inventories while taking into account the diversity of cultural and lingual contexts in which the learning objects and their metadata are reused.

By specifying a common conceptual data schema, this part of this standard ensures that bindings of learning object metadata (LOM) have a high degree of semantic interoperability. As a result, transformations between bindings will be straightforward.

This part of this standard specifies a base schema, which may be extended as practice develops, e.g., facilitating automatic, adaptive scheduling of learning objects by software agents.

2. References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies.

IETF RFC 2048:1996, Multipurpose Internet Mail Extensions (MIME) Part Four: Registration Procedures.^{1, 2}

IETF RFC 2425: 1998, MIME Content-Type for Directory Information.^{2, 3}

IETF RFC 2426: 1998, vCard MIME Directory Profile.^{2, 3}

ISO 639-1:2002, Codes for the Representation of Names of Languages—Part 1: Alpha-2 Code.^{4, 5}

ISO 639-2:1998, Codes for the Representation of Names of Languages—Part 2: Alpha-3 Code.⁵

ISO 3166-1:1997, Codes for the Representation of Names of Countries and their Subdivisions—Part 1: Country Codes.⁶

ISO 8601:2000, Data Elements and Interchange Formats—Information Interchange—Representation of Dates and Times.⁷

ISO/IEC 646:1991, Information Technology—ISO 7-Bit Coded Character Set for Information Interchange.^{8, 9}

ISO/IEC 10646-1:2000, Information Technology—Universal Multiple-Octet Coded Character Set (UCS)—Part 1: Architecture and Basic Multilingual Plane.¹⁰

OED:1989, Oxford English Dictionary, 2nd Ed. 1989.¹¹

¹IETF RFC documents are available at <http://www.ietf.org/rfc>.

²Multipurpose Internet Mail Extensions (MIME) extends the format of Internet mail to allow non-US-ASCII textual messages, non-textual messages, multipart message bodies, and non-US-ASCII information in message headers.

³This standard defines how contact details for people and organizations can be represented. The vCard MIME Directory Profile is defined in IETF RFC 2425:1998 and IETF RFC 2426:1998.

⁴ISO publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁵This is an international standard for the representation of languages. ISO 639-1:2002 defines two-letter language codes, e.g., “en” for English, “fr” for French, “nl” for Dutch, etc. These language codes are a basis for the IETF registry of language tags, as specified in RFC 1766:1995 [B6]. Tags for the identification of languages. ISO 639-2:1998 defines three-letter language codes, e.g. “grc” for Ancient Greek, “eng” for English.

⁶This is an international standard for the representation of country codes, e.g., “BE” for Belgium, “CA” for Canada, “FR” for France, “GB” for United Kingdom, “US” for United States, etc.

⁷This is an international standard that specifies numeric representations of date and time. The basic notation is YYYY-MM-DD where YYYY is the year in the usual Gregorian calendar, MM is the month of the year between 01 (January) and 12 (December), and DD is the day of the month between 01 and 31.

⁸ISO/IEC publications are available from the ISO Central Secretariat, Case Postale 56, 1 rue de Varembe, CH-1211, Genève 20, Switzerland/Suisse (<http://www.iso.ch/>). ISO/IEC publications are also available in the United States from Global Engineering Documents, 15 Inverness Way East, Englewood, Colorado 80112, USA (<http://global.ihs.com/>). Electronic copies are available in the United States from the American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, USA (<http://www.ansi.org/>).

⁹This is an international standard that defines the international 7-bit coded character set with national variants.

¹⁰This is an international standard that specifies a character set that relies on 32 bits, includes approximately 4 billion characters, of which the first 65536 are Unicode, the first 256 are ISO 8859-1, and the first 128 are ASCII.

¹¹The Oxford English Dictionary is available at <http://www.oed.com>.

3. Definitions

3.1 category: A group of related data elements.

3.2 datatype: A property of distinct values, indicating common features of those values and operations on those values.

3.3 extended data element: An element of a data structure that is defined outside a standard and is permitted within an instance of the data structure.

3.4 LangString: A datatype that represents one or more character strings. A LangString value may include multiple semantically equivalent character strings, such as translations or alternative descriptions. *See also: datatype.*

3.5 learning object: For this standard, a learning object is defined as any entity, digital or non-digital, that may be used for learning, education, or training.

3.6 learning object metadata (LOM) data element: A data element for which the name, explanation, size, ordering, value space, and datatype are defined in this standard.

3.7 smallest permitted maximum: For implementation-defined values, the smallest permitted maximum value.

NOTE—See 4.5.

3.8 value space: The set of values for a given datatype (ISO/IEC 11404:1996 [B5]).

NOTE—In LOM, a value space is typically enumerated outright, or defined by reference to another standard or specification.

4. Overview of the metadata structure

4.1 Basic metadata structure

Data elements describe a learning object and are grouped into categories. The LOMv1.0 base schema (see Clause 6) consists of nine such categories:

- a) The *general* category groups the general information that describes the learning object as a whole.
- b) The *lifecycle* category groups the features related to the history and current state of this learning object and those who have affected this learning object during its evolution.
- c) The *meta-metadata* category groups information about the metadata instance itself (rather than the learning object that the metadata instance describes).
- d) The *technical* category groups the technical requirements and technical characteristics of the learning object.
- e) The *educational* category groups the educational and pedagogic characteristics of the learning object.
- f) The *rights* category groups the intellectual property rights and conditions of use for the learning object.
- g) The *relation* category groups features that define the relationship between the learning object and other related learning objects.
- h) The *annotation* category provides comments on the educational use of the learning object and provides information on when and by whom the comments were created.
- i) The *classification* category describes this learning object in relation to a particular classification system.

Collectively, these categories form the LOMv1.0 base schema. The classification category may be used to provide certain types of extensions to the LOMv1.0 base schema, as any classification system can be referenced.

4.2 Data elements

Categories group data elements. The LOM data model is a hierarchy of data elements, including aggregate data elements and simple data elements (leaf nodes of the hierarchy). In the LOMv1.0 base schema, only leaf nodes have individual values defined through their associated value space and datatype. Aggregates in the LOMv1.0 base schema do not have individual values. Consequently, they have no value space or datatype. For each data element, the LOMv1.0 base schema defines the following:

- *name*: the name by which the data element is referenced;
- *explanation*: the definition of the data element;
- *size*: the number of values allowed;
- *order*: whether the order of the values is significant (only applicable for data elements with list values; see 4.3);
- *example*: an illustrative example.

For simple data elements, the LOMv1.0 base schema also defines:

- *value space*: the set of allowed values for the data element—typically in the form of a vocabulary or a reference to another standard (see 3.8);
- *datatype*: indicates whether the values are LangString (see Clause 7), DateTime (see Clause 8), Duration (see Clause 9), Vocabulary (see Clause 10), CharacterString, or Undefined.

Both the size and datatype information may include smallest permitted maximum values.

Extensions to the LOMv1.0 base schema shall retain the value space and datatype of data elements from the LOMv1.0 base schema. Extensions shall not define datatypes or value spaces for aggregate data elements in the LOMv1.0 base schema.

The numbering schema of the data elements represents an aggregation hierarchy of data elements and their components. As an example, the aggregate data element 7.2:Relation.Resource has two components: 7.2.1:Relation.Resource.Identifier and 7.2.2:Relation.Resource.Description. The former data element is in turn an aggregate, as it contains the following components: 7.2.1.1:Relation.Resource.Identifier.Catalog and 7.2.1.2:Relation.Resource.Identifier.Entry. (See 4.3 for the interpretation of aggregate data elements that have list values.)

All data elements are optional. This means that a conforming LOM instance may include values for any data element defined in Clause 6. As the LOMv1.0 base schema in Clause 6 imposes an aggregation relationship, components can, by definition, only be present in a LOM instance as a component of the aggregate element to which they belong. As an example, 7.2.1:Relation.Resource.Identifier appears by definition as a component of 7.2:Relation.Resource. In that sense, the presence of the component implies automatically the presence of the aggregate element to which the component belongs.

4.3 List values

In some instances, a data element contains a list of values, rather than a single value. Lists of values are as follows:

- *ordered*: the order of the values in the list is significant. For example, in a list of authors of a publication, the first author is often considered the more important one. As another example, in a hierarchical classification structure, the order is from more general to more specific.
- *unordered*: the order of the values in the list bears no meaning. For example, if the description of a simulation includes three short texts that describe the intended educational use in three different languages, then the order of these texts is not significant. They may appear in any order without loss of information.

If an aggregate data element contains a list of values, then each of these values shall be a tuple of component elements. For example, the LOMv1.0 base schema specifies that the data element 1.1:General.Identifier contains an unordered list of values. This means that the value of the data element 1.1:General.Identifier is an unordered list of tuples (1.1.1:General.Identifier.Catalog and 1.1.2:General.Identifier.Entry). In this case, for each individual 1.1:General.Identifier value, 1.1.1:General.Identifier.Catalog determines the catalog from which the corresponding 1.1.2:General.Identifier.Entry originates.

4.4 Vocabularies

Vocabularies are defined for some data elements. A vocabulary is a recommended list of appropriate values. Other values, not present in the list, may be used as well. However, metadata that rely on the recommended values will have the highest degree of semantic interoperability; i.e., the likelihood that such metadata will be understood by other end users or systems is highest.

The value of data elements with associated vocabularies shall be represented as a pair (source, value), as detailed in Clause 10. If the source is “LOMv1.0,” then the value space is described by this edition of this standard.

NOTE—If the source is not “LOMv1.0,” then users and implementers are encouraged to create vocabularies that do not conflict with this standard.

If a vocabulary is used that intersects with the LOMv1.0 vocabulary, then only the values not included in this standard should have a source that is not “LOMv1.0.” This will maximize semantic interoperability for the values that are included in this standard.

Example:

As an illustration, we give examples of the different cases for the data element 5.2:Educational.LearningResourceType:

- a) If the value is just contained in the vocabulary, for instance, “Questionnaire,” then this would be represented as (“LOMv1.0,” “Questionnaire”). This option is preferred if the values in the vocabulary can adequately express the intended meaning.
- b) If the user wants to assign a value that is not part of the list given for 5.2:Educational.LearningResourceType, then the user may designate the value as, for instance, (“http://www.vocabularies.org/LearningResourceType,” “MotivatingExample”). This option provides more flexibility to the indexer of learning objects, at the expense of semantic interoperability. Values defined in one community of users, or by an individual end user, will not be used consistently throughout a larger community. In example b), a URI was used to indicate the source of the vocabulary. This approach may be good practice, but using a URI is not a requirement.

The meaning associated with a vocabulary value is defined by the corresponding term in OED:1989, unless explicitly defined in the LOMv1.0 base schema.

NOTE—Future amendments to this standard may incorporate the use of registries.