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Information technology — Procedures for achieving metadata registry content consistency — Part 6: Framework for generating ontologies based on ISO/IEC 11179-3 Ed. 3

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Foreword

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ISO/IEC TR 20943 consists of the following parts, under the general title Information technology — Procedures for achieving metadata registry content consistency:

Part 1: Data elements

Part 2: XML structured data

Part 3: Value domains

Part 4: Overview

Part 5: Semantic Metadata Mapping Procedure

Part 6: Framework for generating ontologies based on ISO/IEC 11179-3 Ed.3 (this part)

Introduction

Semantic Web is a term defined by Tim Berners-Lee and recognized as an extension of the current web. The Semantic Web is an evolving extension of the World Wide Web that the semantics of information and services on the web are defined, making it possible for the web to understand and satisfy the requests of people and machines to use the web content¹. For realizing the Semantic Web, various methods and technologies are required. One of the most important things is ontology building. An ontology is an explicit specification of conceptualization and shared vocabulary to model a domain. In other other, an ontology is a formal and exact representation of information by concepts and relations between the concepts².

ISO/IEC 11179 - Metadata registries (MDR) addresses the semantics of data, the representation of data, and the registration of the descriptions of that data. MDR provides a good introduction to metadata concepts, including a lot of insight into certain aspects of the granularity of metadata. MDR contributes knowledge integrity in a large scale. In brief, MDR supports semantic interoperability of data, because it provides a set of shared vocabulary for an application domain.

MDR provides shared and common vocabulary (metadata, semantics, or concepts) sets and an ontology is a set of semantics for a domain. It means we can use metadata for generating ontologies. It allows ontology consisting of common concepts to be built and facilitates use of MDR.

The goal of this part of ISO/IEC 20943 is to provide a framework for generating ontologies based on ISO/IEC 11179-3 Ed.3. The objectives of this part of ISO/IEC 20943 are to promote the followings:

- a) the generation of ontologies consisting of well-defined concepts (i.e., well-known concepts or generalized common concepts, which are accepted by general users as well as domain experts);
- b) support of easy and clear understanding of concepts across corresponding same or similar application domains;
- c) formalized ontology generation;
- d) support of easy definition (building or generation) of ontology;
- e) the enhancement of interoperability between ontologies;
- f) the facilitation of use of MDR.

¹ Wikipedia, http://en.wikipedia.org/wiki/Semantic_Web

² Wikipedia, [http://en.wikipedia.org/wiki/Ontology_\(information_science\)](http://en.wikipedia.org/wiki/Ontology_(information_science))

Information technology — Procedures for achieving metadata registry content consistency — Part 6: Framework for generating ontologies based on ISO/IEC 11179-3 Ed. 3

1 Scope

This part of ISO/IEC 20943 covers the framework for generating ontologies based on ISO/IEC 11179-3 Ed.3, and provides the procedure and mapping model for generating ontologies.

This part of ISO/IEC 20943 describes on the method to generate an ontology for an application domain using concepts in MDR. Most ontologies are composed of concepts (classes), properties, relations between concepts, and instances (objects or individuals). This part considers the generation of ontology consisting of concepts, properties, and relations³.

ISO/IEC 11179-3 Ed.3 has several regions such as basic type region, identification region, designation and definition region, registration region, concept system region, data description region, and so on. However, this part of ISO/IEC 20943 does not involve all regions and their components required for generating ontologies. Therefore, this part employs a part of the regions.

This part of ISO/IEC 20943 does not include the specification for definition of ontologies in a specific ontology description language, such as RDF, RDF-S, OWL, Topic Maps, KIF, and so on.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 11179-1:2004, *Information technology — Metadata registries (MDR) — Part 1: Framework for the specification and standardization of data elements*

ISO/IEC 11179-3:2010, *Information technology — Metadata registries (MDR) — Part 3: Registry metamodel and basic attributes*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Terms defined in ISO/IEC 11179-3 Ed.3

This part of ISO/IEC 20943 makes use of all terms defined in ISO/IEC 11179-3 Ed.3.

3.2 Definitions

3.2.1

class

<ontology> set, collection, concept, class in programming, type of objects, or kind of things

³ Wikipedia, [http://en.wikipedia.org/wiki/Ontology_\(information_science\)](http://en.wikipedia.org/wiki/Ontology_(information_science))

NOTE 1 In ISO/IEC 20943-6, a class is a concept in the general ontology definition.

NOTE 2 A class in this part is mapped to one of just two concepts, that is, a conceptual domain or an object class, in ISO/IEC 11179-3.

**3.2.2
datatype**

<ontology> set of distinct values, characterized by properties of those values and by operations on those values

**3.2.3
mapping model**

a model for mapping between concepts of 11179-3 Ed.3 and concepts (classes) of general ontologies

**3.2.4
ontology**

a formal representation of the knowledge by a set of concepts within a domain and the relations between those concepts

NOTE This part of ISO/IEC 20943 considers that an ontology consists of three components (class, property, and relation) used for describing most ontologies regardless of ontology description languages.

**3.2.5
procedure**

a specified series of processes or operations which have to be executed in the same manner in order to always obtain the same result under the same circumstances

**3.2.6
property**

<ontology> aspect, attribute, feature, characteristic, or parameter that object (and class) can have

NOTE In ISO/IEC 20943-6, the property is the same meaning with the characteristic in ISO/IEC 11179-3 Ed. 3.

**3.2.7
relation**

<ontology> ways in which classes and individuals can be related to one another

NOTE In ISO/IEC 20943-6, a relation expresses the relationship between classes.

4 Overview

This part of ISO/IEC 20943 prescribes a framework based on ISO/IEC 11179-3 Ed. 3. This part of ISO/IEC 20943 includes a procedure and a mapping model for generating ontologies, as described below:

- A procedure for generating ontologies;
- A mapping model which maps between concepts of ISO/IEC 11179-3 Ed.3 and concepts of general ontologies.

4.1 Framework

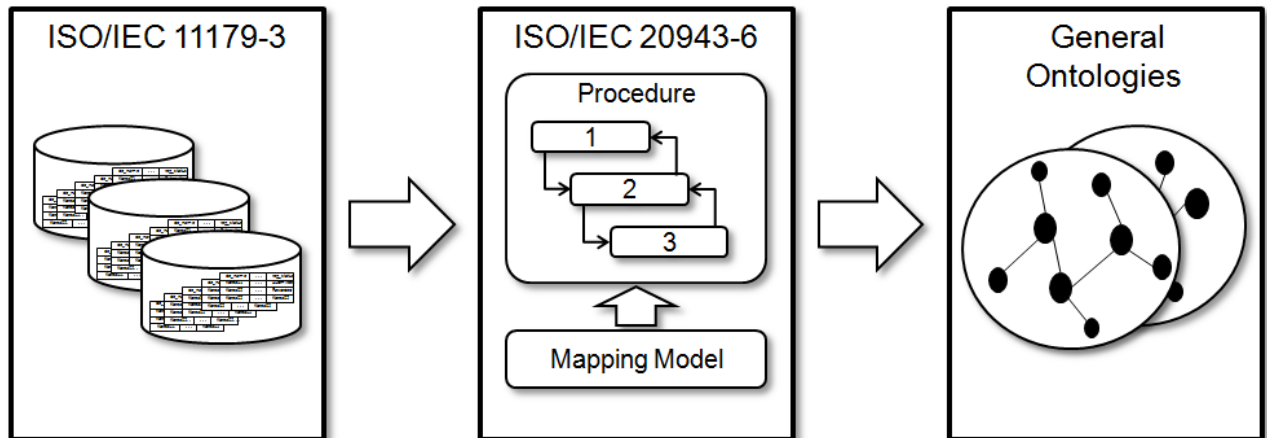


Figure 1 — A Framework for generating ontologies

Figure 1 shows a framework for generating ontologies. ISO/IEC 11179-3 Ed.3 is a registry to administer and register metadata and ontologies. ISO/IEC 20943-6 refers to common concepts of ISO/IEC 11179-3 for generating general ontologies. The common concepts are defined as general ontologies through a mapping model and a procedure.

4.2 Procedure

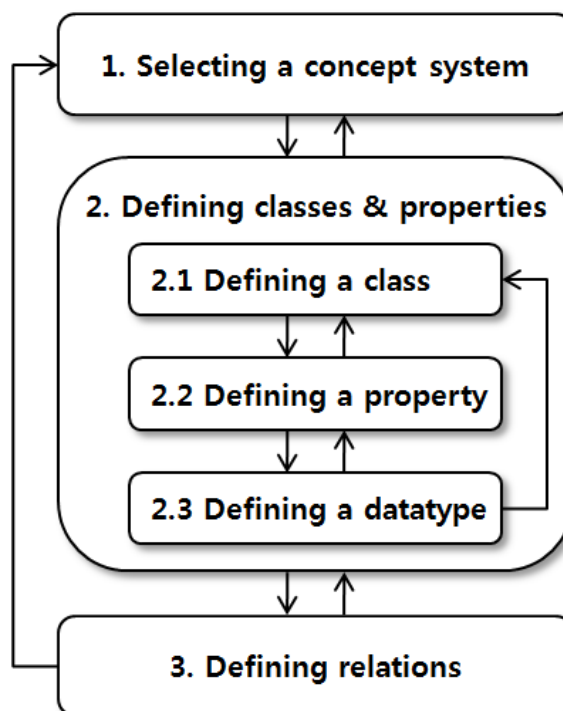


Figure 2 A procedure for generation ontologies

Figure 2 is a procedure for generating ontologies, and it mainly has three steps. And the step 2(classes and properties definition) consists of three sub-steps, as follows:

— Step 1: Selecting a concept system;

- Step 2: Defining classes and properties;
- Step 2.1: Defining a class;
- Step 2.2: Defining a property;
- Step 2.3: Defining a datatype.
- Step 3: Defining relations.

4.2.1 Step 1: Selecting a concept system

This step selects a concept system which contains concepts to generate and specify the domain and scope of general ontologies.

4.2.2 Step 2: Defining classes and properties

This step defines classes and properties of general ontologies using a mapping model which refers to concepts which are defined in the selected concept system at the first step. A concept system region and data description region are defined as Class, Property, and Datatype respectively.

4.2.2.1 Step 2.1: Defining a class

This sub-step defines a class of general ontologies. Through the mapping model, the concepts of 11179-3 Ed. 3 which are included in the concept system region or the data description region are defined as Class of general ontologies.

4.2.2.2 Step 2.2: Defining a property

This sub-step defines a property of the class which is defined in the previous step 2.1. The concepts of data description region are defined as properties of general ontologies. After this step 2.2, main procedure could be moved in next step 2.3 in order to define datatypes of general ontologies or previous step 2.2 in order to define other classes of general ontologies.

4.2.2.3 Step 2.3: Defining a datatype

This sub-step defines a datatype of the property defined in the previous step 2.2. Through the mapping model, the datatype of general ontologies could be defined using the concepts of data description region. This sub-step also could be moved in the previous sub-step or next sub-step.

4.2.3 Step 3: Defining relations

This sub-step defines relations between classes which are defined the previous step 2. Through the mapping model, the concepts are defined in the concept system region or the data description region could be created as Relation of general ontologies. After this step 3, the main procedure returns to the previous step 1 or step 2.

4.3 Mapping Model

In order to generate general ontologies from common concepts based on ISO/IEC 11179-3 Ed. 3, a mapping model which maps between concepts of ISO/IEC 11179-3 Ed. 3 and concepts of general ontologies is required. The mapping model is based on concepts of ISO/IEC 11179-3 Ed. 3 in concept system region (4.3.1) and data description region (4.3.2).

4.3.1 A Mapping Model for Concept System Region

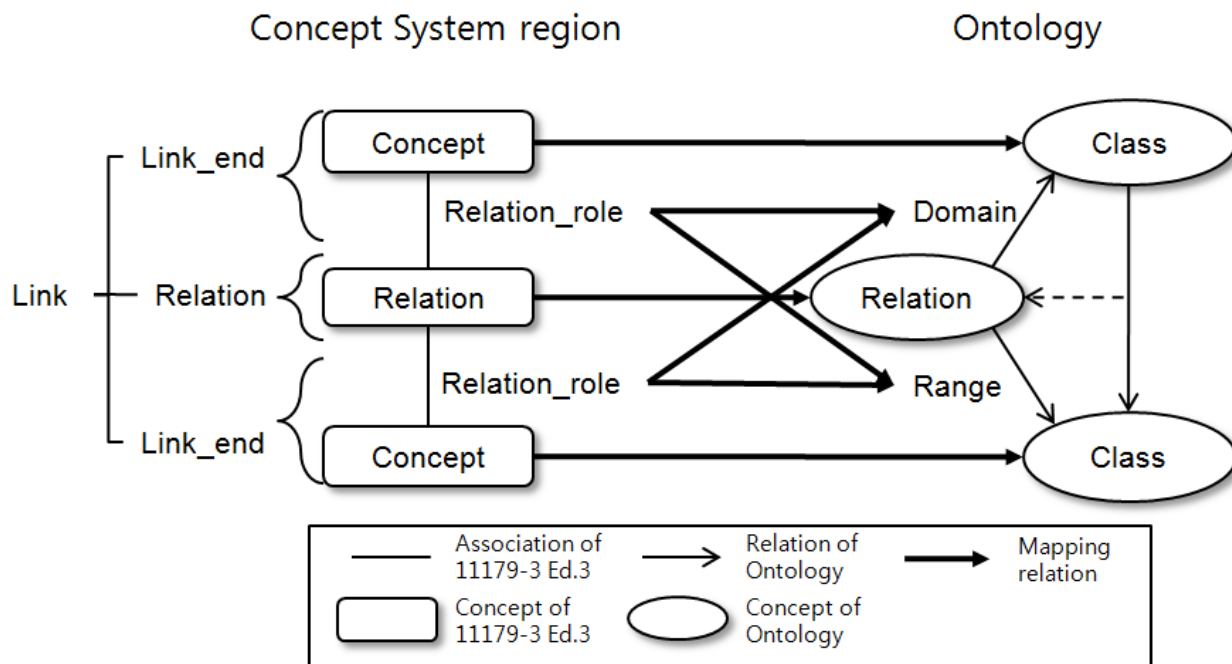


Figure 3 — A mapping model for concept system region

Figure 3 shows a mapping model for concept system region.

In Concept system region, there are five concepts used for mapping model. Concept, Link, Link_end, Relation, and Relation_role defined in concept system region of ISO/IEC 11179-3 Ed. 3 are mapped to Class and Relation of general ontologies.

- Concept: Concept defined in ISO/IEC 11179-3 Ed. 3 is mapped to Class of general ontologies;
- Link: Link defined in in ISO/IEC 11179-3 Ed. 3 searches for Link_end associated with Concept by Relation;
- Link_end: Link_end defined in ISO/IEC 11179-3 Ed. 3 links between Relation_role and Concept and can search for Class associated with Relation by Link_end;
- Relation: Relation defined in ISO/IEC 11179-3 Ed. 3 is mapped to Relation of general ontologies;
- Relation_role: Relation_role defined in ISO/IEC 11179-3 Ed. 3 is mapped to domain and range of general ontologies. Relation defined in ISO/IEC 11179-3 Ed. 3 drives directions of Relation of general ontologies when it is mapped.

4.3.2 A Mapping Model for Data Description Region

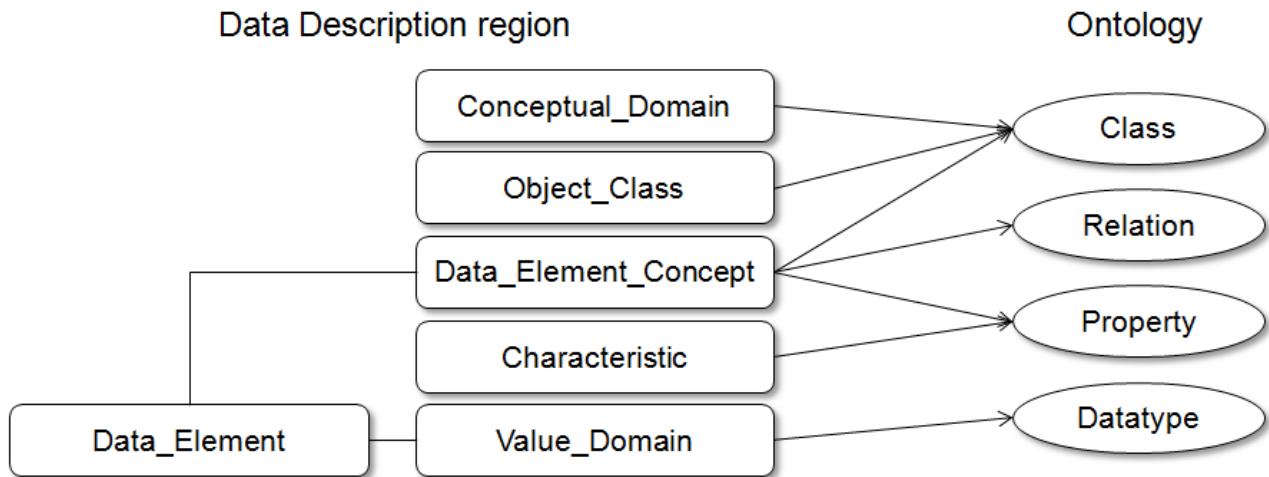


Figure 4 — A mapping model for data description region

Figure 3 shows a mapping model for data description region. This step refers to seven concepts for generating general ontologies. Characteristics, Conceptual_Domain, Data_Element, Data_Element_Concept, Object_Class, Unit_of_Measure, and Value_Domain of which Data Description consists map Class, Relation, Property, Datatype.

— Mapping Characteristic: Characteristic defined in data description region is mapped to Property of general ontologies;

— Mapping Conceptual Domain: Conceptual Domain defined in ISO/IEC 11179-3 Ed. 3 is mapped to Class of general ontologies;

— Mapping Data Element: Data Element defined in ISO/IEC 11179-3 Ed. 3 links between Data Element Concept and Value_Domain. Hence mapped Property has Datatype from Data Element Concept associated with Data Element;

— Mapping Data Element Concept: Data Element Concept defined in ISO/IEC 11179-3 Ed. 3 is mapped to Class, Relation, and Property of general ontologies. Object Class and Characteristic associated with Data Element Concept is mapped to Class and Property. Characteristic is specially mapped to ontology Relation which connects Object class and Conceptual Domain to describe the relationship between Data Element Concept and Conceptual Domain;

— Mapping Object Class: Object Class defined in ISO/IEC 11179-3 Ed. 3 is mapped to Class of general ontologies;

— Mapping Value Domain: Value Domain defined in ISO/IEC 11179-3 Ed. 3 is mapped to Datatype of general ontologies.

Annex A (Informative)

An example of ontologies using the mapping model

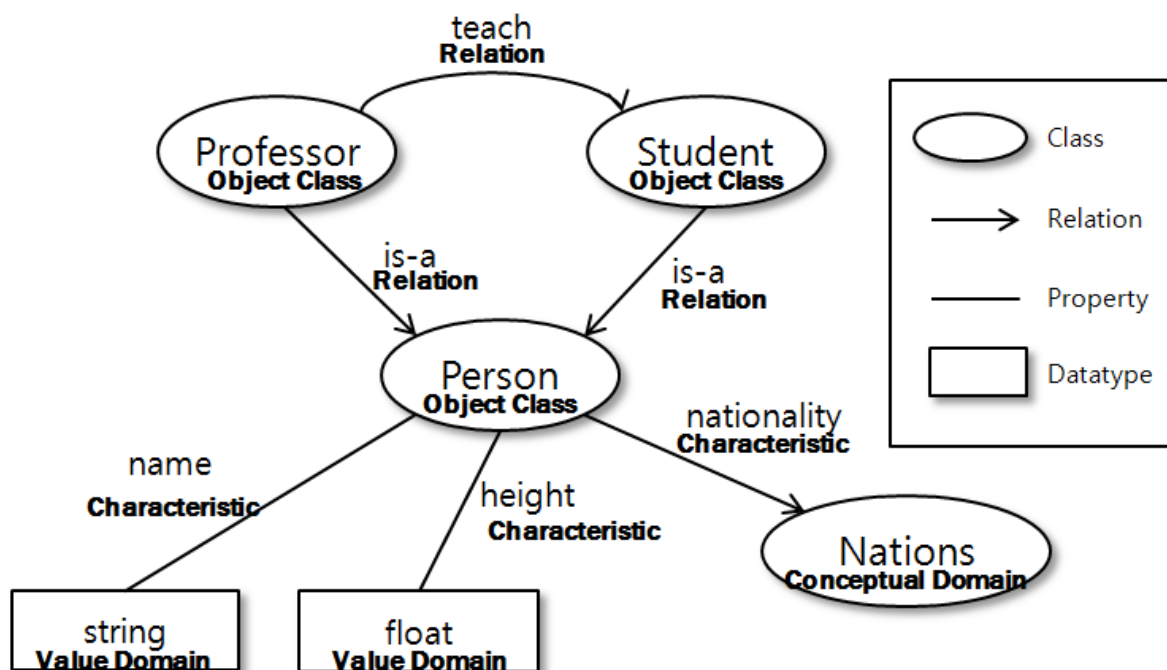


Figure A.1 — An example of ontologies using mapping model

Figure A.1 shows a graphical example of generated ontologies using the mapping model. Each components of an example is mapped by the mapping model between concepts of 11179-3 Ed. 3. The following tables are mapping examples in concept system region and data description region.

Table A.1 — Mapping examples in concept system region

Concepts of 11179-3 Ed. 3 in Concept System region	Concepts of General ontologies	Examples
Concept	Class	Person, Professor, Student
Relation	Relation	is-a, teach

Table A.2 — Mapping examples in data description region

Concepts of 11179-3 Ed. 3 in Data Description region	Concepts of Ontology	Examples
Object_Class	Class	Person, Professor, Student
Conceptual_Domain	Class	Nations

Characteristic	Relation	nationality
Characteristic	Property	name, height
Value_Domain	Datatype	string, float