OWL-Full Metamodeling with SWCLOS

Seiji Koide[1] and Hideaki Takeda[2]

[1] The Graduate University for Advanced Studies (SOKENDAI), 2-1-2, Hitotsubashi, Chiyoda-ku, Tokyo 101-8430 Japan
koide@nii.ac.jp,
WWW home page: http://www-kasm.nii.ac.jp/~koide/
[2] National Institute of Informatics and SOKENDAI
takeda@nii.ac.jp

Abstract. There are some logic-based approaches to metamodeling in OWL. We enabled OWL metamodeling with an object-based approach. In this paper, we introduce criteria for metamodeling, that are derived from the principles of object-oriented metamodeling, and demonstrate examples of metamodeling with SWCLOS.

1 Introduction

Metamodeling in OWL has been discussed in the OWL 1.1 activity and other efforts [1, 2]. All of them are logic-based, and they discuss how to extend DL-based OWL to OWL-Full, not how to accomplish RDF(S) semantics in OWL. In contrast, RDF(S) per se has potential for metamodeling. We developed SWCLOS [3], an OWL-Full modeling language based on the Common Lisp Object System, by leveraging RDF(S) semantics. As in RDF(S), SWCLOS provides the capability to capture a class as an individual in OWL. One still must abide by RDF(S) semantics to deal with classes as individuals.

2 Metamodeling Criteria from an OO Perspective

To capture an object as an instance, a class of an object must be established from an object-oriented (OO) perspective. This principle is extended to the class-metaclass relationship for metamodeling. Namely, in order to capture a class as an individual, we establish a class of classes (metaclass). In the object-oriented embodiment, an entity inherits the attributes and virtues of metaclasses (metaclass-hood) from a superclass as a metaclass. The source of the metaclass-hood is rdfs:Class in the RDF universe. Therefore, every metaclass must be a subclass of rdfs:Class.

Some ontologies, e.g. SUMO and Cyc, embrace embarrassing class-instance relationships, e.g. cyclic membership and disorder between classes and metaclasses. We introduce metamodeling criteria to increase reasoning decidability while paying attention to membership classification and extension inclusiveness. If a class C is an instance of another class whose extension includes the extension of class C, we distinguish such classification from normal ones and denote the relation by $\in_{\subseteq}$. The metamodeling criteria we set up are as follows.

– If a class C is an instance of but not a subclass of D (normal), then D can be a metaclass. $CEXT^{\mathcal{I}}(D^{\mathcal{I}})$ denotes the extension of the denotation of D.

$$\{C^{\mathcal{I}} \in CEXT^{\mathcal{I}}(D^{\mathcal{I}}) \mid CEXT^{\mathcal{I}}(C^{\mathcal{I}}) \subseteq CEXT^{\mathcal{I}}(rdfs\!:\!Resource^{\mathcal{I}})\} \models CEXT^{\mathcal{I}}(D^{\mathcal{I}}) \subseteq CEXT^{\mathcal{I}}(rdfs\!:\!Class^{\mathcal{I}}) \quad (1)$$

– If a class C is an instance of and a subclass of D (abnormal), then D cannot be a metaclass.

$$\{C^{\mathcal{I}} \in_{\subseteq} CEXT^{\mathcal{I}}(D^{\mathcal{I}}) \mid CEXT^{\mathcal{I}}(C^{\mathcal{I}}) \subseteq CEXT^{\mathcal{I}}(rdfs\!:\!Resource^{\mathcal{I}})\} \not\models CEXT^{\mathcal{I}}(D^{\mathcal{I}}) \subseteq CEXT^{\mathcal{I}}(rdfs\!:\!Class^{\mathcal{I}}) \quad (2)$$

These criteria yield a guideline for metamodeling on how to resolve class-instance disorder; if a class C is a subclass of and an instance of class D (abnormal) through B that is a subclass of D, and if C is an instance of but not a subclass of class B (normal), then we can accept such an abnormal C by making B a subclass of rdfs:Class (metaclass).

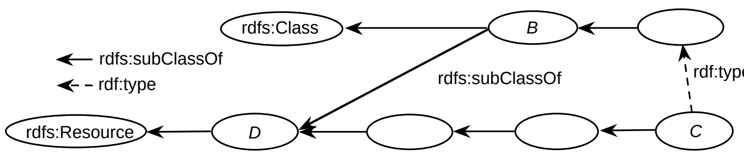

Fig. 1. Example of Meta-Modeling Criteria

3 Concluding Remarks and Demonstration

rdfs:Class plays multiple roles, as a metaclass, meta-metaclass, meta-meta-metaclass, and so forth because of its membership loop. Therefore, the above criteria create an infinite number of clearly separated layers of metamodeling, i.e. class layer, metaclass layer, meta-metaclass layer, and so forth. We demonstrate several examples of metamodeling with SWCLOS at the poster and demos.

References

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OWL-Full Metamodeling with SWCLOS: Demonstration

Seiji Koide[1] and Hideaki Takeda[2]

[1] The Graduate University for Advanced Studies (SOKENDAI), 2-1-2, Hitotsubashi, Chiyoda-ku, Tokyo 101-8430 Japan
`koide@nii.ac.jp`,
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[2] National Institute of Informatics and SOKENDAI
`takeda@nii.ac.jp`

1 Introduction of SWCLOS

In the demonstration, we show the performance of SWCLOS[3] as an OWL reasoner at first. For example, we demonstrate loading Wine and Food Ontology, it takes about 4 seconds from two RDF/XML files, and then show several OWL entailments and satisfiability checking by SWCLOS.

2 About SUMO Ontology

In SUMO ontology,[4] `sumo:Meter`, which is an instance of `sumo:SystemeInternationalUnit`, is a subclass of `sumo:PhysicalQuantity`. However, `sumo:SystemeInternationalUnit` is a subclass of `sumo:UnitOfMeasure`, which is also a subclass of `sumo:PhysicalQuantity`. Therefore, these assertions hold following abnormal conditions.

$$sumo\!:\!Meter^{\mathcal{I}} \in_{\subseteq} CEXT^{\mathcal{I}}(sumo\!:\!PhysicalQuantity^{\mathcal{I}}) \quad (1)$$

$$CEXT^{\mathcal{I}}(sumo\!:\!Meter^{\mathcal{I}}) \subseteq_{\in} CEXT^{\mathcal{I}}(sumo\!:\!PhysicalQuantity^{\mathcal{I}}) \quad (2)$$

We demonstrate SWCLOS signals an alarm against this abnormal class-instance relationship on one hand, and on the other hand, show SWCLOS can accept this abnormality with making `sumo:SystemeInternationalUnit` a meta-class through adding the following assertion.

```
<rdfs:Class rdf:ID= "UnitOfMeasure">
  <rdfs:subClassOf rdf:resource ="&rdfs;Class"/>
</rdfs:Class>
```

3 Metamodeling Programming using SWCLOS

We also demonstrate how to program ontology with metamodeling using SWCLOS and discuss the details with audience.

[3] It is available from `http://www-kasm.nii.ac.jp/~koide/`.
[4] http://www.ontologyportal.org/