A Good Role Model for Ontologies: Collaborations

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ABSTRACT
Although ontologies are gaining more and more acceptance, they are often not engineered in a component-based manner due to, among various reasons, a lack of appropriate constructs in current ontology languages. This hampers reuse and makes creating new ontologies from existing building blocks difficult. We propose to apply the notion of roles and role modeling to ontologies and present an extension of the Web Ontology Language OWL for this purpose. Ontological role models allow for clearly separating different concerns of a domain and constitute an intuitive reuse unit.

Keywords: Collaboration, Ontologies, Role Modeling, Roles, Web Ontology Language (OWL)

1 INTRODUCTION
Ontology languages are emerging as the de facto standard for capturing semantics on the web. One of the most important ontology languages today is the Web Ontology Language (OWL), standardized and recommended by the World Wide Web Consortium (W3C) (Patel-Schneider et al., 2004). One issue currently addressed in the research community is how to define reusable ontologies or ontology parts. In more general terms, how to construct an ontology from possibly independently developed components.

OWL natively provides some facilities for reusing ontologies and ontology parts. First, a feature inherited from RDF (Hayes et al., 2004), upon which OWL is layered, is linking—loosely referencing distributed web content and other ontologies using URIs. Second, OWL provides an owl:imports construct which syntactically includes the complete referenced ontology into the importing ontology. The linking mechanism is convenient from a modeling perspective, but is semantically not well-defined—there is no guarantee that the referenced ontology or web content exists. Furthermore, the component (usually an ontology class) is small and often hard to detach from the surrounding ontology in a semantically well-defined way. Usually a full
ontology import is required since it is unclear which other classes the referenced class depends on. The owl:imports construct can only handle complete ontologies and does not allow for partial reuse. This can lead to inconsistencies in the resulting ontology due to conflicting modeling axioms. Overall, OWL seems to be inflexible in the kind of reuse provided, especially regarding the granularity of components.

Existing approaches addressing these issues often refer to modular ontologies and, in general terms, aim at enabling the reuse of ontology parts or fragments in a well-defined way (for some work in this direction, see Cuenca Grau et al., 2006, 2007a, 2007b). That is, investigate how only certain parts of an ontology can be reused and deployed elsewhere. While it is interesting work and allows for reuse, we believe that such extracted ontological units fail to provide an intuitive meaning of why those units should constitute components—they were not designed as such.

The object-oriented software community has long discussed new ways of modeling software. One interesting result of this research is the notion of role modeling (Reenskaug et al., 1996). The main argument is that today’s class-oriented modeling mixes two related but ultimately different notions: natural types and role types. Natural types capture the identity of its instances, while a role type describes their interactions. Intuitively, an object cannot discard its natural type without losing its identity while a role type can be changed depending on the current context of the object. Person for example, is a natural type while Parent is a role type. Parent is a role that can be played by persons. A role type thus only models one specific aspect of its related natural types. Related role types can be joined together into a role model to capture and separate one specific concern of the modeled whole.

In this article we introduce role modeling to ontologies. Role modeling can bring several benefits to ontologies and ontological modeling. Roles provide:

- More natural ontological modeling by separating roles from classes
- An appropriate notion and size of reusable ontological components—role models
- Separation of concerns by capturing a single concern in a role model

We believe that role models constitute useful and natural units for component-based ontology engineering. Role models are developed as components and intended to be deployed as such, in contrast to existing approaches aimed at extracting ontological units from ontologies not necessarily designed to be modular. While we argue that modeling with roles is beneficial to ontological modeling and provides a new kind of component not previously considered for ontologies, the transition from object-orientation is not straightforward. The contribution of this article is the introduction of modeling primitives to support roles in ontologies and a discussion of the main differences for role modeling between ontologies and object-oriented models (henceforth, the latter are simply referred to as models). The semantics of the new modeling primitives is provided by translation into the assumed underlying ontological formalism of Description Logics (DLs) (Baader et al., 2003). That way, existing tools can be reused for modeling with roles. To convince the reader of the usefulness of role models, we demonstrate their use on two examples. The first example shows separation of concerns and the second example demonstrates reuse of role models in different contexts.

The remaining part of the article is structured as follows. Section 2 introduces roles as used and understood in object-orientation and discusses the main differences between models and ontologies. Section 3 introduces role models to ontologies and gives examples of their use. Section 4 discusses related work to component-based ontology modeling and section 5 concludes the article and discusses open issues.
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