

Chapter 11

Referencing Resources through Ontology Evolution¹

Déliar Rogozan

LICEF Research Center, Canada

Gilbert Paquette

LICEF Research Center, Canada

ABSTRACT

- A Model of Ontology Evolution
 - Ontology Evolution
 - Process Model for Ontology Evolution
- Compatibility Analysis and Change propagation
 - Preservation of Instances
 - Preservation of the Conceptual Structure
 - Preservation of the Inference Capacity
 - Change Propagation to Semantic References
- An Ontology of Ontology Changes
 - Classification of Change Operations
 - Properties of Change Operations
- Managing Ontology Changes and the Semantic Referencing of Resources
 - A Software Framework for Managing Ontology Changes
 - Managing the History of Ontology Changes
 - Managing the Semantic Referencing of Resources

Evolution is a fundamental requirement for useful ontologies. Knowledge evolves continuously in all fields of knowledge due to the progress in research and applications. Because they are theories of knowledge in a precise domain, Ontologies need to evolve because the domain has changed, the viewpoint of the domain has changed or because problems in the original domain conceptualization have to be resolved or have been resolved (Noy

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& Klein, 2003). Moreover, in open and dynamic environments such as the Semantic Web, the ontologies need to evolve because domain knowledge evolves continually (Heflin & Hendler, 2000) or because ontology-oriented software-agents must respond to changes in users' needs (Stojanovic, Maedche, Stojanovic, & Studer, 2003).

This chapter explores some important issues of ontology evolution. Firstly, it presents a unified model of ontology evolution, that we have modeled using the MOT representation language. Afterward, it illustrates an ontological representation of changes in OWL ontologies. These changes are seen as a local transformation from a previous ontology model to a new one. Both ontologies are expressed using the MOT+OWL visual language presented in Chapter 10. Thirdly, it proposes a framework for managing ontology changes and for managing the semantic referencing of resources, in the Semantic Web context. For this purpose, visual modeling has been used to define the main functionalities of interactive tools to support ontology evolution, with the objective to help maintain a coherent and useful referencing of resources by the ontology.

11.1 A MODEL OF ONTOLOGY EVOLUTION

As any complex processes, ontology evolution requires a model that structures it. Although current researches propose models of ontology construction, these are far from approaching ontology evolution in an elaborated way (Haase & Sure, 2004). Besides, there is no consensus regarding the proposed models of ontology evolution. This is due to the different perspective on what ontology evolution consists. In a centralized context, it signifies the application of changes to an ontology and the exclusive usage of this evolved ontology (Maedche, Motik, & Stojanovic, 2003; Stojanovic, 2004). In a decentralized context, the evolution denotes the identification, the alignment and the

management of multiple versions of a same ontology (Klein, 2004; Klein & Noy, 2003).

The need of a unified model of ontology evolution is thus necessary. This section describes a process model of ontology evolution. It defines the notion of evolution, which is the basis of the model and it provides a description of steps that compose the process of ontology evolution, thus providing a basis for the other sections of this chapter.

Definition of Ontology Evolution

Ontology evolution signifies the timely modification of an ontology according to modifications of its domain, conceptualization or usage. This modification is enacted by the application of changes to an ontology version (V_N) in order to produce a new ontology version (V_{N+1}), while preserving the ontology consistency and role. The *ontology role* refers to the services provided by the ontology and to its usage. For example, in the Semantic Web context, the ontology is used to assure the semantic referencing of resources so that resources can be found by the knowledge they contain. The *ontology consistency* designates the state where all invariants of the ontology model are respected. Invariants are structural and axiomatic constraints that must hold in every stable state of an ontology, any change that invalidates them is inconsistent for example, adding a data property with no value or an intersection axiom on a class that is a subset of only another classe.

Figure 1 illustrates two examples of inconsistent models that could results from a change to an ontology. The first one declare the class "Course Manager" as a subclass of "Designer IMS_LD", while this class was already declared as a subclass of "Course Manager", because of the transitivity of the (S) links. The second example declares "Designer IMS_LD" as a subclass of disjoint classes "PedagogicalDesigner" and "Tutor", which of course means that this class is empty.

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