Using Ontology Languages for Conceptual Modeling

Palash Bera, Texas A&M International University

Anna Krasnoperova, Bootlegger, Canada

Yair Wand, University of British Columbia, Canada

ABSTRACT

Conceptual models are used to support understanding of and communication about application domains in information systems development. Such models are created using modeling grammars (usually employing graphic representation). To be effective, a grammar should support precise representation of domain concepts and their relationships. Ontology languages such as OWL emerged to define terminologies to support information sharing on the Web. These languages have features that enable representation of semantic relationships among domain concepts and of domain rules, not readily possible with extant conceptual modeling techniques. However, the emphasis in ontology languages has been on formalization and being computer-readable, not on how they can be used to convey domain semantics. Hence, it is unclear how they can be used as conceptual modeling grammars. We suggest using philosophically based ontological principles to guide the use of OWL as a conceptual modeling grammar. The paper presents specific guidelines for creating conceptual models in OWL and demonstrates, via example, the application of the guidelines to creating representations of domain phenomena. To test the effectiveness of the guidelines we conducted an empirical study comparing how well diagrams created with the guidelines support domain understanding in comparison to diagrams created without the guidelines. The results indicate that diagrams created with the guidelines led to better domain understanding of participants.

Keywords: *Conceptual Modeling, Domain Semantics, Ontology Languages, OWL*

1. INTRODUCTION

An *Information Systems (IS) or formalized ontology* is an "explicit specification of a conceptualization," where a conceptualization is an "abstract, simplified view of the world" (Gruber, 1993). IS ontologies, also termed *computational ontologies*, have been introduced to support communication, information sharing, and reuse of IS components (Uschold & Gruninger, 1996). In the Semantic Web context, IS ontologies are used to represent semantics of web sources. Manola and Miller (2004) proposed the Resource Description Framework (RDF), an infrastructure to enable the encoding, exchange, and reuse of structured metadata on the Web. Using RDF as a framework, ontology languages such as OWL (*Web Ontology Language*) have

DOI: 10.4018/jdm.2010112301

been proposed for creating formal ontologies to serve as descriptions of terminologies used in web documents (McGuinness, Smith, & Welty, 2004).

While IS ontologies can be used to represent terminologies of domains of interest, they are intended for computational purposes, not for domain representation. In this paper we address the use of an ontology language to create representations of business domains. Such representations are termed Conceptual Models (Mylopoulos, 1992; Wand & Weber, 2002). Smith (2001) has observed that a philosophical ontology establishes truth about reality, while an IS ontology is a software artefact designed with specific uses and computational environments in mind. Accordingly, we adopt a philosophical ontology to suggest guidelines for using OWL in conceptual modeling.

Below, Section 2 discusses OWL and difficulties that may arise when using it for conceptual modeling. Section 3 introduces the ontological model we use to assign semantics to OWL constructs. Sections 4 and 5 provide specific suggestions on using OWL in conceptual modeling. Section 6 describes an empirical study to test the suggestions. Section 7 is the conclusion.

2. BACKGROUND

Conceptual modeling is the activity of formally describing some aspects of the physical and social world around us for purposes of understanding and communication (Mylopoulos, 1992). The more common uses of conceptual models in the IS field are to: (1) facilitate communications between users and analysts, (2) support the analysts' understanding of the domain, (3) serve as the basis for design and implementation of IS, and (4) record design rationales (Kung & Solvberg, 1986). While conceptual models provide input for design, they do not represent the IS artefact. In particular, conceptual models are different than semantic data models. In particular, conceptual models are created for studying a business, while semantic data models are created for designing a database.

While an IS ontology defines a set of concepts, a conceptual model uses concepts to represent a specific domain. Conceptual models are created using modeling grammars comprising constructs for representing domain phenomena, and rules for combining these constructs (Shanks *et al.*, 2003). There are at least two reasons why it might be advantageous to use an ontology language as a conceptual modeling grammar. First, using a formalized ontology language can provide for including the semantics of domain concepts as part of the conceptual model. Second, ontology language statements are intended to be processed by software applications and can be subject to automated reasoning. Hence, conceptual models represented in ontology languages can be subject to automated processing, in particular to verification beyond what graphical representation affords.

However, ontology language constructs do not have the domain semantics required from conceptual models. We propose that since philosophical theories of ontology can represent domain phenomena (Shanks *et al.*, 2003; Wand & Weber, 2002), such theories can guide the use of ontology languages for conceptual modeling.

2.1 OWL

OWL (McGuinness *et al.*, 2004) has been created by the W3C (World Wide Web Consortium) ontology working group to enable publishing and sharing of IS ontologies on the web. OWL is currently considered one of the key semantic web technologies that provide a framework for data sharing and reuse on the Web (Gomez-Perez, Fernandez-Lopez, & Corcho, 2004). OWL constructs are classes, individuals, properties of classes and individuals, and assertions about these properties. Further, OWL allows reasoning about classes and individuals (based on its formal semantics). OWL is divided into three layers of increasing level of expressiveness: OWL Lite, OWL Description