Chapter 4.4
Domain Ontologies

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INTRODUCTION

In conceptual modeling we need to consider a general level of abstraction where the domain of interest is formalized in an independent way with respect to the specific application for which the conceptual modeling process is performed. This leads to an integrated approach that takes into account knowledge about a domain and metaknowledge about a methodology. Indeed, knowledge about a domain is represented by a system of concepts and instances that reify the knowledge that is managed within a domain, and the metaknowledge about a methodology is the description of the knowledge deriving from the method used. For instance, when a technology is used to unveil ontologies within a specific domain, the knowledge about the domain is the resulting ontology, and the metaknowledge about a methodology is the description of the method used to construct the ontology. In this article, a novel method for the creation of both upper level and specific domain ontologies, called the bidirectional method for developing ontologies, is described. In particular, it will guide the developer to obtain ontologies resulting from the combination of both top-down and bottom-up approaches. The first one focuses on conceptual modeling through "armchair" research (philosophical, psychological, sociological aspects) and figures out a formal draft schema. The second approach employs an automatic (or semiautomatic) extraction of categories, taxonomies, partonomies, and dependency graphs in particular from linguistic corpora of documents related to the topics of the domain.

BACKGROUND

Formal ontologies are a popular research topic in several communities, such as knowledge management, knowledge engineering, natural language processing, artificial intelligence (AI),

and others (Fensel, 2000). Formal ontology can be defined as the systematic, formal, axiomatic development of the logic of all forms and modes of being (Cocchiarella, 1991). More generally, we employ the term formal ontology to designate an explicit specification of a shared conceptualization that holds in a particular context. In other words, an ontology provides an explicit conceptualization that describes semantics of data, providing a shared and common understanding of a domain (from an AI perspective, see the definitions of Gruber, 1998, and Jasper & Ushold, 1999). Ontologies are used to manage knowledge within and among communities, to manage and organize corporate knowledge bases, and to negotiate meanings among individuals. Moreover, ontologies are used to share knowledge among people, and heterogeneous and widely spread application systems, such as semantic-Web applications (Schwartz, 2003). They are implied in projects, as conceptual models, to enable content-based access on corporate knowledge memories, knowledge bases, or data warehouses. They are employed to allow agents to understand each other when they need to interact, communicate, and negotiate meanings. Finally, they refer to common information and share a common understanding of their structure.

In computer science, knowledge management, knowledge representation, and other fields, several languages and tools exist for helping final users and system developers in creating good and effective ontologies. In particular, various tools help people in manually or semiautomatically creating categories, partonomies, taxonomies, and other organization levels of ontologies. The generally accepted term to designate these tools is ontology editors. Some of them are open source such as Protégé-2000, KAON, and SWOOP, and others are commercial suites for knowledge management based on ontology development, such as tools provided by the onto-Knowledge Project (for an in-depth description, see http://protege.stanford. edu, http://kaon.semantic web.org/, http://www. mindswap.org/2004/SWOOP/, http://www.on-toknowledge.org/index.shtml).

Some Important Methodologies

Behind these tools and techniques, different (domain-independent) approaches and methods are used to develop numerous heterogeneous ontologies. In particular, Ushold's (2000; who proposed codification in a formal language) methodology and methontology, which constructs an ontology in a sequence of intermediate representations finally translated into the actual object (Fernández, Gòmez-Pérez, & Juristo, 1997), are the most representative. Here are short descriptions of some important methodologies:

- One of the first modules of the foundational ontologies library is the descriptive ontology for linguistic cognitive engineering (DOLCE). DOLCE is an ontology of particulars and refers to cognitive artefacts that depend on human perception, cultural imprints, and social conventions. This ontology derives from armchair research in particular, referring to enduring and durable entities from philosophical literature. The main authors' idea is to develop not a monolithic module, but a library of ontologies (WonderWeb Foundation Ontologies Library) that allows agents to understand one another despite enforcing them to interoperate by the adoption of a single ontology (Masolo, Borgo, Gangemi, Guarino, & Oltramari, 2002). Finally, basic functions and relations (according to the methodology introduced by Gangemi, Pisanelli, & Steve, 1998) should be general enough to be applied to multiple domains, be sufficiently intuitive and well studied in the philosophical literature, and hold as soon as their relations are given without mediating additional entities.

- In Gatius and Rodríguez (1996), the authors developed a three-step process (natural-lan-

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