A Knowledge Engineering Approach to Develop Domain Ontology

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ABSTRACT

Ontologies are one of the most popular and widespread means of knowledge representation and reuse. A few research groups have proposed a series of methodologies for developing their own standard ontologies. However, because this ontological construction concerns special fields, there is no standard method to build domain ontology. In this paper, based on discussing and analyzing representative ontology building methodologies, the authors propose a knowledge engineering approach to build domain ontology by combining software development life cycle standard IEEE 1074-2006 with design ontology criteria proposed by T. R. Gruber. The authors use the ontology editor Hozo to develop a marine biology ontology for an e-learning course. They verify the validity and rationality of marine biology ontology by applying it to a practical system called OASIS. The authors then demonstrate the applicability of their proposed knowledge engineering approach.

Keywords: Domain Ontology, Hozo, Knowledge Engineering, Marine Biology Ontology, Ontology Evaluation

1. INTRODUCTION

The term ontology is originated from philosophy, where ontology is a systematic account of Existence. Ontologies are now widely used in knowledge engineering, artificial intelligence and computer science. In theory, ontology is “a formal, explicit specification of a shared conceptualization” (Gruber, 1993). An ontology “consists of concepts, hierarchical (is-a) organization of them, relations among them (in addition to is-a and part-of), axioms to formalize the definitions and relations” (Mizoguchi, 2003).

Domain ontology models a specific domain, or part of the world. It represents the particular meanings of terms and relations among them as they apply to that domain, or the dominant theory in that domain.

The aim of ontology research is therefore to develop knowledge representations that
can be shared and reused. Domain ontologies provide shared and common understanding of a specific domain.

Presently, ontologies are becoming a widely used tool for modeling knowledge in adaptive web systems (Chen & Mizoguchi, 2004). One of the leading application areas is E-learning. Domain, user, instructional ontologies are analyzed as tools for e-learning enhancement. We develop ontology as a tool for sharing and reuse on the subject knowledge.

A few research groups have proposed a series of steps and methodologies for developing their own standard ontologies. However, due to the fact that ontological construction aims at special fields and lacks mature method, it’s crucial to research methodologies for the development of domain ontology. We discuss and analyze some representative methodologies. Combining software development life cycle standard IEEE 1074-2006 (IEEE, 1996) with design ontology criteria proposed by T. R. Gruber (1995), we propose a knowledge engineering approach to construct domain ontology. Following this approach, we develop marine biology ontology for e-learning course.

The aim of this paper is to analyze the process of the development of domain ontology and to present our practical work in this field. This paper is organized as follows: In section 2, we discuss and analyze some representative methodologies. In section 3, based on the analysis of discussed methodologies, we propose a knowledge engineering approach to build domain ontology. In section 4, following our proposed approach, we describe marine biology ontology development process in detail. In section 5, we verify the validity and rationality of marine biology ontology by applying it in a practical system called OASIS. Finally, we give a conclusion and future works.

2. ANALYSIS OF METHODOLOGIES FOR BUILDING ONTOLOGY

There are different methodologies for ontology development during a number of years. We present and analyze some representative methodologies against the IEEE Standard for Developing Software Life Cycle Process, 1074-2006 (IEEE, 1996).


The IEEE 1074-2006 (IEEE, 1996) is a standard for developing software project life cycle processes. It describes the software development process, the activities to be carried out, and the techniques that can be used for developing software. IEEE 1074-2006 software development life cycle flow includes 5 phases: Specification, Conceptualization, Formalization, Implementation and Maintenance. The aim of developing ontology is knowledge acquisition. Specification and Conceptualization is necessary precondition to implement knowledge acquisition. Evaluation works on the Implementation and Maintenance phase. Documentation works throughout the whole ontology development life cycle.

2.2. Overview of Some Methodologies

Some representative methodologies for building ontology are Skeletal methodology (which is for enterprise modeling process) (Uschold et al., 1998), TOVE methodology (which is for the domain of business processes and activities modeling) (Gruninger & Fox, 1995), METHONTOLOGY (Fernández et al., 1997) (which is developed within the Laboratory of Artificial Intelligence at the Polytechnic University of Madrid.), Seven-Step method (Noy & McGuinness, 2001) (which is developed by medical college in Stanford University). Several authors analyze and develop domain ontologies for specific topics in e-learning such as improving the English financial language studies (Angelova, Kalaydjiev, & Strupchanska, 2004). Other papers deal with domain frameworks or recommendations for ontology development, e.g., Gavriloa (Gavriloa, Farzon, & Brusilovsky, 2005) presents one practical algorithm of creating teaching ontology. Boyce and Pahl (2007) present a method to develop ontologies
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