Chapter 9
Ontology Learning in Practice:
Using Semantics for Knowledge Grounding

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ABSTRACT

This chapter presents research results, showing the use of ontology learning for knowledge grounding in e-learning environments. The established knowledge representation model is organized around actions, as the main elements linking the acquired knowledge with knowledge-based real-world activities. A framework for action ontology building from domain-specific corpus texts is suggested, utilizing different Natural Language Processing (NLP) techniques, such as collocation extraction, frequency lists, word space model, etc. The suggested framework employs additional knowledge sources of WordNet and VerbNet with structured linguistic and semantic information. Results from experiments with crawled chemical laboratory corpus texts are presented.

INTRODUCTION

Learning process can be described as being aimed at helping the learner to understand and interpret reality, to acquire facts, skills and methods for interacting with real world and influencing its changes. The success of this process to a large extent depends on proper knowledge representation, showing the relationship between the ability of interpreting the theoretical information and observations of reality. E-learning systems, currently playing significant role in education, are very sensitive to the knowledge representation problem, as they make use of extensive distributed learning resources, created by employing collective intelligence of domain experts and professionals. On the other side, e-learning systems, based on the use of computer technologies, are very well suitable for implementing computer-based knowledge engineering and reasoning mecha-

nisms for knowledge grounding. A key challenge for computerized knowledge grounding is the design of a formal conceptual information layer, known as ontology, facilitating the arrangement of descriptive information and knowledge in an orderly way in order to establish a system of basic statements for reasoning mechanisms. By the use of ontologies knowledge can be managed and shared in a commonly understandable way, facilitating knowledge representation, natural language processing (NLP) and information retrieval tasks (Studer et.al., 1998).

The aim of this chapter is to present a knowledge grounding and representation model, making use of ontology learning from domain-specific corpora. The model building process is illustrated by developing an action-centered ontology, utilizing crawled online material on chemistry laboratory processes (experiments, basic rules, tool descriptions, manuals, techniques, etc., making a total of 1,971,415 running words). The collected texts were morphologically annotated and lemmatized using *Stanford University NLP* tools for English language[1]. The developed prototype ontology contains 528 named classes, 3457 axioms (including 1070 logical axioms) and 1855 annotation assertion axioms. It can be incorporated in e-learning systems or used in other knowledge-management applications for reasoning about the observed reality.

BACKGROUND

Ontology-based knowledge grounding avoids problems with concept ambiguity and lack of semantic relations between concepts. The use of ontology enables the unification of different representations for the same object and allows easy data exchange between different systems. In this case, ontology can be interpreted as a concept database for formal development of information, preferences and knowledge (IPK) (Gadomski, 1999). The main idea of cognitive *IPK* architecture

is the generalization of available data by applying information and preference relations for the choice of proper statements. Information categorization and prioritization is used in order to get explicit reasonable statements for a particular domain. In the Top-down Object-based Goal-oriented Approach (TOGA meta-theory), ontology is considered to be a goal-oriented and role-depended set of concepts (Gadomski, 1993). The TOGA descriptive knowledge is defined by relation rules, physical laws, theories and models, and its operational knowledge is expressed by algorithms, methods, instructions, procedures and actions.

The ISO 1087-1 standard (2000) defines a concept as a "unit of knowledge created by a unique combination of characteristics" (p. 2). It is language independent, but can be influenced by the context. Thus, the ontology learning process can be described by the following steps: a) selecting the knowledge object, b) learning information about this object – defining concepts, terms, and a set of constraints, c) defining rational criteria for the evaluation of learned knowledge d) documenting (Ushold & King, 1995).

The above presented methodology is sufficient for ontology learning from scratch using domain-specific corpus texts. However, it does not include any methods for the integration of other knowledge resources. From this point of view, the ontology engineering methodology named as *Methontology* (Mariano, et. al., 2004) is more complete. It suggests a framework for multi-step ontology learning, based on prototypes. Each prototype has to be planned – time and resources for each ontology building task have to be determined. Ontology learning starts from ontology specification, defining the domain, purpose, scope and knowledge source information. Further ontology development tasks include conceptualization (building a conceptual model), formalization (specifying techniques and tools) and implementation (Figure 1). Ontology development is accompanied by parallel activities of knowledge acquisition – extraction, integration and

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