Chapter 1.19
Approaches to Semantics in Knowledge Management

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ABSTRACT

There are different approaches to modeling a computational system, each providing different semantics. We present a comparison among different approaches to semantics and we aim at identifying which peculiarities are needed to provide a system with uniquely interpretable semantics. We discuss different approaches, namely, Description Logics, Artificial Neural Networks, and relational database management systems. We identify classification (the process of building a taxonomy) as common trait. However, in this chapter we also argue that classification is not enough to provide a system with a Semantics, which emerges only when relations among classes are established and used among instances. Our contribution also analyses additional features of the formalisms that distinguish the approaches: closed versus. open world assumption, dynamic versus. static nature of knowledge, the management of knowledge, and the learning process.

INTRODUCTION

The growing demand for information and knowledge management is pushing research efforts in computer science towards the development of technologies that allow massive amounts of

data to be automatically processed and stored, for the user to dispose of them. In areas like SW (Semantic Web) applications, KR (Knowledge Representation), RDBMS (Relational Database Management Systems), and logic-based systems, research has led, during the last decade, to impressive advances in the creation and the implementation of applications that facilitate the management of knowledge. The availability of such an enormous amount of information also resulted in the necessity to develop systems with the ability to integrate information that originate from heterogeneous sources and organize them into a single source.[1]

On the one hand, these systems allow for not only data storage and retrieval, but also additional logic-based processing, like checking consistency of data; on the other hand, they require to combine different data storage systems (e.g., different database instances) or even different interpretation paradigms (e.g., relational calculus, logical formalisms, or the structure underlying neural networks). Particularly, the integration of heterogeneous data sources poses challenges when their storage systems differ in their underlying semantics, that is, when their logical interpretations do not adhere to the same paradigm. As an example, consider independent organizations collaborating in the EE (Extended Enterprise): the capability of combining into a single data source the data stored in a relational database and the axioms that constitute a *KB (Knowledge Base)* may represent a striking advantage on the market or industry. In this situation, before starting the integration process, it is necessary to have a clear sense of how to correctly join the semantics of the different sources.

The purpose of this chapter is to introduce three popular approaches to knowledge representation, underpinned by different semantics, to show in what they differ, and to present two alternative approaches to the problem of information integration. Particularly, we will focus on the notion of semantics and on the different features that

contribute to the notion of semantics for each of the approaches described in this chapter. A good explanation of the concept of semantics in the various approaches requires some introductory knowledge of basic logical formalisms, like propositional and predicate logics. In order to explain how different can result the representation of the same domain and data in different formalisms, we define a sample scenario that will be developed and represented in the distinct formalisms in the next sections.

This chapter is organized as follows. First, we describe a sample scenario that we will use to show differences among the chosen formalisms; then we present the formalisms, starting with elementary notions of propositional and predicate logic and, continuing with the introduction of some concepts in RDBMS, ANNs, and DLs theories. We accompany the theories with explanations on how to consider the features of each formalism and how they lead to different interpretations of the scenario. Finally, we describe two popular integration efforts among different formalisms, namely optimization of query answering in DLs, exploiting RDBMS storage with DL-Lite and OWA/CWA integration with hybrid reasoning.

A SAMPLE SCENARIO

The scenario we will illustrate is the trading of goods; it involves companies, products, articles, markets, and consumers. We introduce these concepts in order to sketch our sample scenario; they will be represented in the different approaches with the addition of instance data to populate the schema.

The main categorization defined by the example is the one distinguishing among different kinds of enterprises. A *company* is a generic entity that provides something (e.g., a service, a product, or another type of goods). *Manufacturer*, *distributor*, and *reseller* are further categorizations of company, while the concept *suppliers*

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