Semantic Enrichment in Ontologies for Matching

Nwe Ni Tun, Japan Advanced Institute of Science and Technology, Japan
Satoshi Tojo, Japan Advanced Institute of Science and Technology, Japan

ABSTRACT

Matching between heterogeneous ontologies becomes crucial for interoperability in distributed and intelligent environments. Although many efforts in ontology mapping have already been conducted, most of them rely heavily on the meaning of entity names, rather than the semantics defined in ontologies. In order to deal with semantic heterogeneity, we propose a semantically enriched model of ontologies (called MetaOntoModel) where every domain concept is treated as a sort—an entity type that carries identity criteria for its instances—and classified these concepts based on three philosophical notions: identity, rigidity, and dependency. According to the classification, concept-level properties (called meta-knowledge) are embedded for each concept. Our novel idea is that if two concepts are semantically equivalent, then they have the same meta-knowledge. On the contrary, if two concepts possess different kinds of meta-knowledge, then they cannot be matched. We also prove that meta-knowledge can determine not only the scope of semantic correspondences, but also which properties are the most relevant in finding correspondence between two similar concepts.

Keywords: meta model; ontologies; semantic data model; semantic matching

INTRODUCTION

Today, ontologies have become a silver bullet not only in the development of the Semantic Web, but also in several collaborative application areas such as intelligent environments (or smart spaces), e-commerce, social networks, multi-agent systems, etc., because they are respected as a means of consensus for intelligent reasoning and sharing capabilities. Since a single global ontology is no longer enough...
to support the variety of tasks pursued in distributed environments, the Web involves a proliferation of ontologies, and faced a trade-off between interoperability and heterogeneity.

Heterogeneity is both a welcome and unwelcome feature because it improves the efficiency of applications on one hand, but it degrades interoperability on the other hand. In order to keep a balance between heterogeneity and interoperability, ontology matching has become a plausible solution in various tasks such as ontology merging, query answering, information retrieval, exchange, and integration, etc. Heterogeneity is generally distinguished in terms of syntactic heterogeneity and semantic heterogeneity. Syntactic heterogeneity is caused by using different ontology modeling paradigms (e.g., RDF-based model or frame-based model) and different ontology languages (e.g., DAML or OWL), while semantic heterogeneity is created by conceptualization divergence in describing the semantics of ontological classes. Research on resolving syntactic heterogeneity has been undertaken by many researchers so far (Bowers & Delcambre, 2000; Chalupsky, 2000). In this article, we focus on the semantic heterogeneity between ontologies.

In practice, a matching process between formally axiomatized ontologies with a variety of heterogeneities is a highly complex process, and a considerable amount of expert-interaction is still involved in verification. For ontology matching, our underlying assumption is “the more explicit semantics is specified in ontologies, the feasibility of matching will be greater.” Hence, an important step in handling semantic heterogeneity should be the attempt to enrich the semantics of concepts with adequate conceptualization consistency.

The semantic enrichment techniques use a variety of knowledge sources such as shared thesaurus like WordNet¹, linguistic knowledge, and intensional and extensional knowledge (Su, 2004). However, Mitra and Wiederhold claim that full automation for mapping using linguistic knowledge is not feasible due to the inadequacy of today’s NLP technology (Mitra & Wiederhold, 2002). It is also obvious that the semantics of similar concepts described by either intensional knowledge (attributes and relations) or extensional knowledge (sets of instances), in two different ontologies, can possibly be heterogeneous according to the diverse knowledge of domain experts.

Our enrichment approach is based on the classification of concepts using some philosophical notions. According to the classification, concept-level properties (called meta-knowledge) are defined for each concept. The idea behind our approach is that the meta-knowledge carries an identifiable link between two heterogeneous descriptions of a concept. Though the description of a concept can be slightly different according to domain experts, the meta-knowledge of the concept is not distinctive for the same semantics. For this purpose, we introduce a semantically

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General Adaptation Framework: Enabling Interoperability for Industrial Web Resources


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