Chapter 9

ONTOLEGY SPECIFICATION AND INTEGRATION FOR MULTIMEDIA APPLICATIONS

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Abstract: An ontology designed for multimedia applications should enable integration of the conceptual and media spaces. We present M-OWL, a new ontology language, that supports this capability. M-OWL supports explicit definition of media properties for the concepts. The language has been defined as an extension of OWL, the standard ontology language for the web. We have proposed a new Bayesian Network based probabilistic reasoning framework with M-OWL for semantic interpretation of multimedia data. We have also proposed a new model for ontology integration, based on the similarity of the concepts in the media domain. It can be used to integrate several multimedia and traditional ontologies.

Key words: Semantic Web; Ontology; Multimedia; Bayesian Network; Reasoning; OWL; M-OWL; Ontology Integration

1. INTRODUCTION

Late twentieth century has seen an explosive growth of the Internet. Availability of a huge volume of information on the net has resulted in a need for its effective utilization by automated means. The Semantic Web [1] envisages an environment, where user agents and other web based applications can make intelligent use of data and services available on the Internet. The technology is maturing fast with rapid inventions in knowledge representation and reasoning schemes, software agent technology, and other related subjects. We have also witnessed a remarkable growth of on-line multimedia data in recent times.
Medical imagery, on-line music, movies, news and sports video are just some of the examples of such collections. This has motivated research in automated semantic access of media data. However, there is a large semantic gap between the information seekers’ perspectives and the media features that are machine-detectable in the multimedia documents. Thus, on-line multimedia data poses significant challenge to the development of the semantic web. Knowledge-based multimedia data processing generally employs application and media specific methods for media data interpretation. Little attention has so far been paid to the standardization and re-usability of the knowledge resources for the web based media processing applications. This chapter has been motivated by the need for multimedia data processing in the Semantic Web environment.

Ontology is an essential ingredient for the Semantic Web. It is a formal specification for conceptualization of a domain [2]. This declarative form of knowledge enables reasoning with the concepts in a domain and facilitates semantic interpretation of information. Development and maintenance of a non-trivial ontology for a practical information system is human-intensive and an extremely expensive process. Today’s networked world provides an opportunity for sharing ontologies by several information systems, leading to economics in their development and maintenance efforts. W3C forum\(^1\) has taken up the task for standardizing ontology representations with formal semantics to promote such sharing. These efforts have led to a number of standard languages for information markup to knowledge representation. OWL or the Ontology Language for the Web, approved in 2004 being the latest in the series. The problem of ontology integration to promote reuse has also attracted attention of several researchers [3–8].

The present day ontology deals with abstract entities, namely the “concepts” and their “properties”. As a result, they help us to reason with a symbolic description of the world. We can use this conceptual reasoning framework for modeling and interpreting textual information embedded in the web-pages and other distributed data sources. In contrast, multimedia information is perceptual in nature. Semantic processing of multimedia data requires a bridge across the perceptual media world and the abstract conceptual world. The present day ontology languages do not support this feature. Moreover, the bridge between the conceptual and the perceptual worlds is characterized with inherent uncertainties [9–12]. The crisp Description Logic [13] based reasoning scheme for present day ontologies is not amenable to uncertain reasoning and cannot be applied for conceptual interpretation of media data.

In this chapter, we present an ontology language that enables semantic processing of multimedia data. It supports explicit specification of media proper-

\(^1\)www.w3c.org.