Chapter XI
Semantic Annotation of Objects

Petr Křemen
Czech Technical University in Prague, Czech Republic

Miroslav Blaško
Czech Technical University in Prague, Czech Republic

Zdeněk Kouba
Czech Technical University in Prague, Czech Republic

ABSTRACT

Compared to traditional ways of annotating multimedia resources (textual documents, photographs, audio/video clips etc.) by keywords in form of text fragments, semantic annotations are based on tagging such multimedia resources with meaning of objects (like cultural/historical artifacts) the resource is dealing with. The search for multimedia resources stored in a repository enriched with semantic annotations makes use of an appropriate reasoning algorithm. Knowledge management and Semantic Web communities have developed a number of relevant formalisms and methods. This chapter is motivated by practical experience with authoring of semantic annotations of cultural heritage related resources/objects. Keeping this experience in mind, the chapter compares various knowledge representation techniques, like frame-based formalisms, RDF(S), and description logics based formalisms from the viewpoint of their appropriateness for resource annotations and their ability to automatically support the semantic annotation process through advanced inference services, like error explanations and expressive construct modeling, namely n-ary relations.

INTRODUCTION

This paper has been motivated by experience gained by the authors in the course of solving the EU project CIPHER (5th Framework Programme 2001-2004). The main output of the project was the Story Fountain (Mulholland et al., 2004)—a software tool providing intelligent support for story research and exploration. Story Fountain is based on a collection of semantically annotated stories and supports the user in exploring these stories, e.g. looking for similarities, finding a
chain of stories, which logically connects two stories etc.

The developed methodology and tools have been tested on two story collections. The first one was devoted to the Bletchley Park. Bletchley Park is located in Bletchley (now integral part of the city of Milton Keynes, UK). It is the place where the British Government’s Code and Cipher School was located during the Second World War. Nowadays, it is a museum of the code breaking work done there. The exhibition located in Bletchley Park emphasizes the influence it has had on contemporary communication and computing technology. The collection consisted of several hundreds of stories, mainly interviews with people having worked there. The other collection consisted of about 50 historical stories related to castles in Southern Bohemia, Czech Republic.

Story Fountain accepts semantic annotations expressed in a subset of Operational Conceptual Modeling Language—OCML (Motta, 1999). OCML is a frame based conceptual modeling language. See next chapter for more information on frames. A frame represents basically an n-ary relation between individuals. Hence, the modeling process is more straightforward in comparison with formalism based on description logics including at that time emerging standard OWL (W3C, 2004), which provide only binary relations and the annotation process is thus much more tedious work than in case of using frame based formalisms. This was the main reason, why OWL was not chosen as the formalism for semantic annotations at the beginning of the project.

Nowadays, OWL is a well established standard with a large community of users and developers. There exist a number of public domain reasoners and other supporting tools. For example we were missing a tool for semantic comparison of two ontologies in OCML—a kind of a semantic diff tool. In OWL environment, the availability of reasoners makes the development of such a semantic diff tool much easier. Another big problem in CIPHER was debugging of semantic annotations. If there was an inconsistency in the annotation, discovering its root was a hard problem for the author of the annotation in Story Fountain. On the other hand, description logics provide a well defined mathematical background, which makes possible to develop effective algorithms for detecting the smallest sets of inconsistent axioms.

The restriction to binary relations seems to be the only one important weak point of OWL as a formalism for authoring semantic annotations. Fortunately, there exists decidable description logic with possibility to express n-ary relations called DLR (Calvanese, 1998). DLR motivated the authors of this chapter to explore the possibility of using DLR as a primary formalism for semantic annotations with subsequent translation to OWL—a key opening the doors to the wealth of publicly available semantic web tools. The rest of this chapter deals with basic aspects of a new methodology for authoring semantic annotations using DLR and OWL based semantic web tools.

STATE OF THE ART

Semantic Networks and Frames

One of the well known knowledge representation formalisms are semantic networks. There are many particular implementations with different graphical notations and different semantics. In principal, a semantic network is a directed or undirected graph, where nodes represent concepts or individuals (instances of concepts) and edges represent semantic relations between various concepts (individuals). Typical relations are: (i) A is-a B—concept A is a specialization of concept B or an individual A is an instance of concept B, (ii) A is-part-of B meaning that B has A as part of itself, (iii) various types of associations. An interesting extension to this basic semantic network paradigm are conceptual graphs (Sowa, 1992). A simplified version of conceptual graphs...