

ALMOST OWL

1 Preamble

In recent years, Semantic Web technologies like RDF(S) [1], DAML+OIL [2], and their common Description Logics [3, 4] based successor OWL [5] have paved the way for standardized formal conceptualizations of all kinds of knowledge. Numerous ontologies have been developed to conceptualize a plethora of domains of discourse [6]. Since corporations from all sectors have braced to define company specific knowledge using Semantic Web technologies, ontology engineering has become a business model for a number of emerging companies.

You are with *Almost OWL Inc.*, which is one of these startups. *Almost OWL Inc.* figured out the enormous potential of Semantic Web technologies and has decided to develop a Description Logics based ontology management system.

Description Logics (DL) are a family of knowledge representation languages that can be used to represent the knowledge of an application domain in a structured and formally well-understood way by first defining the relevant concepts of the domain (its terminology), and then using these concepts to specify properties of objects and individuals occurring in the domain (the world description).

The Web Ontology Language OWL is based on the $\mathcal{ALCQHIR}^+$ Description Logics dialect, which extends the basic Description Logic \mathcal{AL} with negation (\mathcal{C}), qualified number restrictions (\mathcal{Q}), role hierarchies (\mathcal{H}), and inverse (\mathcal{I}) and transitive roles (\mathcal{R}^+). Knowledge representation systems based on Description Logics boast with inference capabilities that make it possible to infer implicit knowledge from explicitly represented knowledge. For instance, the *subsumption* algorithm allows one to determine subconcept-superconcept relationships. A concept \mathcal{C} is subsumed by \mathcal{D} *iff* the set of instances denoted by \mathcal{C} is a subset of the set of instances denoted by \mathcal{D} (i.e., the first description is always interpreted as a subset of the second one). Reasoning in $\mathcal{ALCQHIR}^+$ is of high complexity (EXPTIME). Modern DL systems therefore include a wide range of optimization techniques, which may improve typical case performance by several orders of magnitude [7].

2 Your Task

In order to have a short time to market, you decide to develop an ontology management system for the less expressive Description Logic \mathcal{ALCN} , which is \mathcal{AL} plus negation (\mathcal{C}) and unqualified number restrictions (\mathcal{N}). An introduction to \mathcal{ALCN} is given in [4, 8]. In particular, your ontology management system should implement the *subsumption* algorithm, such that one can query if a concept description \mathcal{C} is subsumed by a concept description \mathcal{D} . An overview of applicable tableau algorithms for Description Logics is given in [9].

3 Considerations

You may start off developing a reasoning engine that supports \mathcal{ALC} concept descriptions and successively implement the complete tableau algorithm for \mathcal{ALCN} .

Furthermore, you may consider that your ontology management system may prospectively be used by client applications such as visualization frontends, which display the classified ontology in a visually pleasing tree view, or parsers, which take as input \mathcal{ALCN} concept- and role descriptions that can eventually be stored in the ontology. In order to make it particularly easy to integrate such kinds of extensions with your ontology management system, you may forethoughtfully devise an extensible software architecture with well defined interfaces.

References

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