Concept abduction for semantic matchmaking in distributed and modular ontologies

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Abstract. Recently, attempts have been done to formalize Semantic Matchmaking, the process of finding potential matches between demands and supplies based on their logical relations with reference to a common ontology, in Description Logics (DLs). We extend the formalization to Packages-based Description Logics (P-DLs), modular extensions of DLs, in order to perform the matchmaking operation in contexts where descriptions of demands and supplies are specified in different terminologies.

Keywords: semantic matchmaking, package-based description logics, distributed ontology, abductive reasoning, tableaux-based methods.

1 Introduction

Recently, several attempts have been done to formalize Semantic Matchmaking, the process of finding potential matches based on logical relations with reference to a *common ontology*, in Description Logics (DLs)[4]. Demands and supplies are thus represented as *concepts* in order to use different inference mechanisms to evaluate possible matches between them according to the semantic relationships. We extend this formalization to the context of Packages-based Description Logics (P-DLs)[2] to allow descriptions of demands and supplies can be specified in *different, distributed* but *interconnected ontologies*. For performing the semantic matchmaking in such settings, we develop a distributed reasoning algorithm based on tableau calculus to compute *concept abduction*, an abductive reasoning service developed specifically for this kind of operation[4], in P-DLs.

2 Distributed abductive reasoning in Package-based Description Logics

Description Logics (DLs)[1] are a family of logic-based languages for representing and reasoning about the knowledge of a domain. Package-based Description Logics (P-DLs) are extensions of DLs to represent distributed and modular ontologies. In P-DLs, a knowledge base (KB) is thus considered as a collection of components called *packages*. In each package, along with its *local terms*, the usage of *foreign terms* imported from other packages are permitted, allowing local knowledge of packages can be reused elsewhere.

Concept Abduction is a novel non-monotonic inference task proposed for description logics to evaluate potential matches between demands and supplies. Given two concepts C, D and a TBox $\mathcal{T}$ such that $C \sqcap D \not\sqsubseteq_{\mathcal{T}} \bot$, this reasoning service allows to find a concept H (hypothesis) such that $C \sqcap H \not\sqsubseteq_{\mathcal{T}} \bot$ and $C \sqcap H \sqsubseteq_{\mathcal{T}} D$.

Extending Concept Abduction to the distributed context of P-DLs, in place of a single TBox $\mathcal{T}$, we have a set of packages $\Sigma = \{P_i\}$. Let $P_w \in \Sigma$ be some *witness package*, the computing of H now need to be done with respect to P_w . To do that, we devise a distributed algorithm which is based on the federated reasoning technique developed for P-DLs[2] and the uniform tableaux-based method[3]. The procedure consists of two stages:

1. At first, we try to build multiple, federated local tableaux for $C \sqsubseteq_w D$[1]. If all such tableaux contain obvious contradiction, then either C is unsatisfiable or the subsumption holds w.r.t Σ as witnessed by P_w and thus no abduction is needed.
2. On the contrary, for all tableaux which are consistent, we compute concept expressions that, when added to the tableaux, will eventually generate some contradiction. If these contradictions imply in fact the subsumption between two concepts C and D, they will be parts of the finding hypothesis H.

3 Conclusions

We have developed a distributed tableaux-based algorithm for solving the concept abduction problem in the distributed and modular context of Package-based Description Logics. This allows to perform the Semantic Matchmaking in situations where demands and supplies are specified with reference to different ontologies. In the future, we would like to optimize this method to achieve better performance.

References

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[1] '$\sqsubseteq_w$' is used to denote that the inference is performed from the local point of view of P_w.