Some Optimizations $\mathcal{R}^+\mathcal{IQ}$ Tableau Algorithm

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1 Introduction

This paper explores some optimization techniques for $\mathcal{R}^+\mathcal{IQ}$ tableau algorithm [1]. $\mathcal{R}^+\mathcal{IQ}$ description logic (DL) is an extension of $\mathcal{RIQ}$ DL [2] that allows one to introduce composition of roles from the right hand side of complex role inclusion axioms (RIAs). The series of papers, so far, have proved decidability of DLs with complex RIAs. However, such DLs permit only the left hand side of the composition of roles with additional restrictions. To avoid analysis of restrictions that roles must satisfy in new RIAs, we consider only one RIA of the form $R \dot{\sqsubseteq} Q \circ P$. Main idea is to define a new tablo constructor and new expansion rules which will deal with these roles.

2 General Idea

Tableau algorithm in [2] tries to construct a tableau for $\mathcal{RIQ}$-concept C. In preprocessing step the role hierarchy is translated into non-deterministic finite automata (NFA), that are used, both, in the definition of a tableau and in the tableau algorithm [1]. Intuitively, an automaton is used to memorize path between an object x that has to satisfy a concept of the form $\forall R.C$ and other objects, and then to determine which of these objects must satisfy C [2]. Similar idea can be used in $\mathcal{R}^+\mathcal{IQ}$ with a RIA of the form $w \dot{\sqsubseteq} Q \circ P$. If an object x should satisfies concept $\forall Q.C$ then we should define structure that will remember path $w \circ P^-$ from the object x to objects that must satisfy concept C. If we extend $\mathcal{RIQ}$ DL with Fun [3], then the next lemma holds:

Lemma 1 *Let C_0 be $\mathcal{R}^+\mathcal{IQ}$ concepts and $\mathcal{R}$ regular Rbox with a RIA of the form $w \dot{\sqsubseteq} QP$, where $Fun(P^-)$ holds. Let U be a new role name. We define*

$$C_1 := \forall U.(\forall w.(\exists P^-.\top)) \sqcap \forall w.(\exists P^-.\top),$$

and set
$\mathcal{R}_1 := \mathcal{R} \backslash \{w \dot{\sqsubseteq} QP\} \cup \{UU \dot{\sqsubseteq} U, U^- \dot{\sqsubseteq} U\} \cup \{R \dot{\sqsubseteq} U | R \in \mathcal{R}_{C_0}\} \cup \{wP^- \dot{\sqsubseteq} Q\}$.

Then, $\mathcal{R}^+\mathcal{IQ}$ concept C_0 is satisfiable w.r.t. RBox $\mathcal{R}$ iff concept $C_0 \sqcap C_1$ is satisfiable w.r.t. Rbox $\mathcal{R}_1$.

Without restriction $Fun(P^-)$, lemma (1) do not holds. To regain the decidability of $\mathcal{R}^+\mathcal{IQ}$ (without restriction $Fun(P^-)$) , in [1] a blocking technique is demonstrated, which supports new expansion rules (see table 1 in [1]). The technique is not optimal. The goal of this paper is to show the improvements of tableau algorithm shown in [1], in order to avoid unnecessary computations.

References

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