



Description Logic

Winter Semester 2017/18

Exercise Sheet 5

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Exercise 5.1 Prove that the negation normal form (NNF) of an \mathcal{ALC} -concept C can be computed in polynomial time and is equivalent to C .

Exercise 5.2 Execute the tableau algorithm $\text{consistent}(\mathcal{A})$ for the normalized ABox

$$\mathcal{A} = \{(b, a) : r, (a, b) : r, (a, c) : s, (c, b) : s, a : \exists s.A, b : \forall r.((\forall s.\neg A) \sqcup (\exists r.B)), c : \forall s.(B \sqcap (\forall s.\perp))\}.$$

If \mathcal{A} is consistent, draw the model generated by the algorithm.

Exercise 5.3 We consider the concept constructor \rightarrow (implication) with the following semantics:

$$(C \rightarrow D)^{\mathcal{I}} := \{x \in \Delta^{\mathcal{I}} \mid x \in C^{\mathcal{I}} \text{ implies } x \in D^{\mathcal{I}}\}.$$

To extend $\text{consistent}(\mathcal{A})$ to this constructor, we propose two alternative new expansion rules:

The deterministic \rightarrow -rule

Condition: \mathcal{A} contains $a : C \rightarrow D$ and $a : C$, but not $a : D$

Action: $\mathcal{A} \longrightarrow \mathcal{A} \cup \{a : D\}$

The nondeterministic \rightarrow -rule

Condition: \mathcal{A} contains $a : C \rightarrow D$, but neither $a : \neg C$ nor $a : D$

Action: $\mathcal{A} \longrightarrow \mathcal{A} \cup \{a : X\}$ for some $X \in \{\neg C, D\}$

For each rule, determine whether the resulting algorithm is still terminating, sound, and complete.

Exercise 5.4 We consider TBoxes \mathcal{T} that only contain the following two kinds of axioms:

- role inclusions of the form $r \sqsubseteq s$, and
- role disjointness constraints of the form $\text{disj}(r, s)$,

where r and s are role names. An interpretation \mathcal{I} satisfies these axioms if

- $r^{\mathcal{I}} \subseteq s^{\mathcal{I}}$, and
- $r^{\mathcal{I}} \cap s^{\mathcal{I}} = \emptyset$, respectively.

Modify the tableau algorithm $\text{consistent}(\mathcal{A})$ to decide consistency of $(\mathcal{T}, \mathcal{A})$, where \mathcal{A} is an ABox and \mathcal{T} a TBox that contains only role inclusions and role disjointness constraints. Show that the algorithm remains terminating, sound, and complete.