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7. Exercises for the Course „Logic-based Knowledge Representation“

Exercise 22:

Consider the following extension of the Description Logic $\mathcal{ALCN}$:

Addition of a new concept constructor $(r \sqsubseteq s)$, where r and s are role names, with the following semantics:

$$(r \sqsubseteq s)^{\mathcal{I}} = \{a \in \Delta^{\mathcal{I}} \mid \text{for all } b \in \Delta^{\mathcal{I}}, (a,b) \in r^{\mathcal{I}} \text{ implies } (a,b) \in s^{\mathcal{I}}\}$$

Then do the following:

(a) Devise a new tableau rule for dealing with the above extension of $\mathcal{ALCN}$.

(b) Sketch the modifications that need to be made to the $\mathcal{ALCN}$-ABox consistency algorithm and its soundness, completeness, and termination proofs when adding a new rule for this extension.

Exercise 23:

In the lecture, it has been proved that the tableau algorithm uses space polynomial in the length of the input ABox—provided that numbers in number restrictions are coded unarily.
Modify the tableau algorithm such that this is also true for binary coding of numbers in number restrictions (and such that it still decides consistency of ABoxes).

Exercise 24:

Let $\varphi := \forall a_1 \exists a_2\ a_1 \rightarrow a_2$ be a quantified Boolean formula.

(a) Show that φ is valid.

(b) Define an $\mathcal{ALC}$-concept C_φ such that φ is valid if and only if C_φ is satisfiable. Describe a canonical model of C_φ.