

PSPACE Tableau Algorithms for Acyclic Modalized \mathcal{ALC}

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Abstract We study \mathcal{ALCK}_m and $\mathcal{ALCS4}_m$, which extend the description logic \mathcal{ALC} by adding modal operators of the basic multi-modal logics K_m and $S4_m$. We develop a sound and complete tableau algorithm Λ_K for answering \mathcal{ALCK}_m queries w.r.t. an \mathcal{ALCK}_m knowledge base with an acyclic TBox. Defining tableau expansion rules in the presence of acyclic definitions by considering only the concept names on the left-hand side of TBox definitions or their negations, allows us to give a PSPACE implementation for Λ_K . We then consider answering $\mathcal{ALCS4}_m$ queries w.r.t. an $\mathcal{ALCS4}_m$ knowledge base (with an acyclic TBox) in which the epistemic operators correspond to those of classical multi-modal logic $S4_m$. The expansion rules in the tableau algorithm Λ_{S4} are designed to syntactically incorporate the epistemic properties. Blocking is incorporated into the tableau expansion rules to ensure termination. We also provide a PSPACE implementation for Λ_{S4} . In light of the fact that the satisfiability problem for \mathcal{ALCK}_m with general TBox and no epistemic properties (i.e., $\mathbf{K}_{\mathcal{ALC}}$) is NEXPTIME-complete, we conclude that both \mathcal{ALCK}_m and $\mathcal{ALCS4}_m$ offer computationally manageable and practically useful fragments of $\mathbf{K}_{\mathcal{ALC}}$.

Keywords Description logic · \mathcal{ALC} · Modal logic · Tableau algorithm · PSPACE

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