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Can Full Set-Theoretical Subsumption Semantics in Metamodelled Description Logics Be Captured Within Decidable FOL Fragments?

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Metamodelling in ontologies enables the structured representation of complex domains by defining relationships between concepts across multiple levels of abstraction. Subsumption, a core relation in hierarchical reasoning, provides a strong foundation for organizing ontological knowledge. In this work, we build on an extended form of higher-order description logic, denoted $HIIRS*(L)$, which supports metamodeling through two semantically fixed roles: instanceOf and subClassOf. These roles explicitly enforce meta-level constraints, allowing for a richer and more expressive representation of both hierarchical and meta-level concepts. While the logic has four known variants with three shown to be decidable, the decidability of the full set-theoretical semantics of the subClassOf relation for all concepts remains open. This work investigates the decidability of the full set-theoretical semantics of the subClassOf relation for all concepts, denoted as $HIRSSA(L)$ for arbitrary base DL, L by seeking to align it with well-established decidable fragments of first-order logic.

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