Hypothetical Datalog: Negation and Linear Recursion*

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Abstract

This paper examines an extension of Horn logic in which rules can add entries to a database hypothetically. Several researchers have developed logical systems along these lines, but the complexity and expressibility of such logics is only now being explored. It has been shown, for instance, that the data-complexity of these logics is $PSPACE$-complete in the function-free, predicate case. This paper extends this line of research by developing syntactic restrictions with lower complexity. These restrictions are based on two ideas from Horn-clause logic: *linear recursion* and *stratified negation*. In particular, a notion of stratification is developed in which negation-as-failure alternates with linear recursion. The complexity of such rulebases depends on the number of layers of stratification. The result is a hierarchy of syntactic classes which corresponds exactly to the polynomial-time hierarchy of complexity classes. In particular, rulebases with k strata are data-complete for Σ_k^P. Furthermore, these rulebases provide a complete characterization of the relational queries in Σ_k^P. That is, any query whose graph is in Σ_k^P can be represented as a set of hypothetical rules with k strata. Unlike other expressibility results in the literature, this result does not require the data domain to be linearly ordered.

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