Expressing Database Queries with Intuitionistic Logic

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Abstract

This paper develops a declarative language with intuitionistic semantics which expresses exactly the generic database queries. Syntactically, the language is an extension of Datalog (function-free Horn logic) which allows rules themselves to appear in the bodies of other rules. Such rules are called *embedded implications*. Several researchers have studied restricted versions of these rules, but in their full incarnation, universal quantifiers may appear in the premises, as in the rule $A \leftarrow \forall_x[B(x) \leftarrow C(x)]$. This paper focuses on these embedded universal quantifiers. It is shown, for instance, that such quantifiers give the logic the ability to create new constant symbols hypothetically during inference. This, in turn, allows the logic to simulate unbounded counters and arbitrary Turing machines. In addition, when the logic is augmented with negation-as-failure, it becomes expressively complete, that is, it can express any database query which is typed and generic. Similar results exist for other languages, but the novelty of this work is that expressive completeness is achieved with a declarative language based on a well-established semantics, i.e., intuitionistic semantics. Indeed, the paper presents a simple proof of the intuitionistic completeness of the logic.

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