INTUITIONISTIC DEDUCTIVE DATABASES AND THE POLYNOMIAL TIME HIERARCHY

ANTHONY J. BONNER

▷ Deductive databases are poor at tasks such as planning and design, where one must explore the consequences of hypothetical actions and possibilities. To address this limitation, we have developed a deductive database language in which a user can create hypotheses and draw inferences from them. In earlier work, we established initial results on the complexity and expressibility of this language. In this paper, we establish more comprehensive results by exploring the interaction of *negation-as-failure* with a natural syntactic restriction called *linearity*. The main result is a tight connection between intuitionistic logic, database queries, and the polynomial time hierarchy. A tight connection with second-order logic follows as a corollary. First, we show that rulebases in our language fit neatly into a well-established logical framework—*intuitionistic logic*. Second, we show that linearity reduces their data complexity from PSPACE to NP. Third, we show that negation-as-failure increases their complexity from NP to some level in the polynomial time hierarchy (PHIER). Specifically, linear rulebases with k strata are data complete for Σ_k^{P}, the k^{th} level in the hierarchy. Fourth, we show that linear rulebases express *exactly* the generic database queries in PHIER. Finally, we characterize the generic queries in Σ_k^{P} in terms of rulebases with k strata. Unlike many other expressibility results in the literature, these results do *not* depend on the artificial assumption that the data domain is linearly ordered. We thus establish a strong link between two well-established, but previously unrelated areas: intuitionistic logic and the polynomial time hierarchy. ◁

Address correspondence to University of Toronto, Department of Computer Science, Toronto, Ontario, Canada M5S 3G4. Email: `bonner@db.toronto.edu`

THE JOURNAL OF LOGIC PROGRAMMING

655 Avenue of the Americas, New York, NY 10010