



Chapter IV

FRIL++ and Its Applications

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Abstract

We introduce a deductive probabilistic and fuzzy object-oriented database language, called FRIL++, which can deal with both probability and fuzziness. Its foundation is a logic-based probabilistic and fuzzy object-oriented model where a class property (i.e., an attribute or a method) can contain fuzzy set values, and uncertain class membership and property applicability are measured by lower and upper bounds on probability. Each uncertainly applicable property is interpreted as a default probabilistic logic rule, which is defeasible, and probabilistic default reasoning on fuzzy events is proposed for uncertain property inheritance and class recognition. The design, implementation, and basic features of FRIL++ are presented. FRIL++ can be used as both a modeling and a programming language, as demonstrated by its applications to machine learning, user modeling, and modeling with words herein.

Introduction

For modeling real-world problems and constructing intelligent systems, the integration of different methodologies and techniques has been the quest and focus of significant interdisciplinary research effort. The advantages of such a hybrid system are that the strengths of its partners are combined and are complementary to each other's weakness.

In particular, object orientation provides a hierarchical data abstraction scheme and an information hiding and inheritance mechanism; probabilistic/fuzzy reasoning provides measures and rules for representing and reasoning with uncertainty and imprecision in the real world; logic programming provides a declarative way for problem specification and well-founded semantics for formal reasoning. However, research on combining all three modeling and computing paradigms appears to be sporadic.

In Eiter et al. (2001), the authors developed algebra to handle object bases with uncertainty, where conditional probabilities for an object of a class being a member of its subclasses are given, and membership of an object to a class is expressed by a probability value, but fuzzy values are not allowed in class properties. Meanwhile, there have been many fuzzy object-oriented models developed, such as those of Bordogna et al. (1999), George et al. (1993), Itzkovich and Hawkes (1994), Rossazza et al. (1997), and Van Gyseghem and De Caluwe (1997), but they are not deductive. Yazici and George (1999) present a deductive fuzzy object-oriented model that, however, does not address uncertain applicability of properties.

In Dubitzky et al. (1999), each property of a concept is assumed to have a probability degree for it occurring in exemplars of that concept. However, the method therein for computing a membership degree of an object to a concept, based on matching the object's properties with the uncertainly applicable properties of the concept, is in our view not justifiable. Also, the work does not address the problem of how inheritance is performed under the membership and applicability uncertainty.

Recently, Blanco et al. (2001) and De Tré (2001) sketched general models to manage different sources of imprecision and uncertainty, including probabilistic ones, on various levels of an object-oriented database model. However, no foundation was laid to integrate probability theory, and fuzzy logic in case probability was used to represent uncertainty. In Cross (2003), the author reviewed existing proposals and presented recommendations for the application of fuzzy set theory in a flexible generalized object model.

In this chapter, we summarize the main features of a logic-based probabilistic and fuzzy object-oriented model where a class property can contain fuzzy sets

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