A Conceptual Design Methodology for Fuzzy Relational Databases

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ABSTRACT

Computer applications in the nontraditional area have put requirements on conceptual data modeling. Some conceptual data models, being the tools of design databases, have been proposed. However, information in real-world applications is often vague or ambiguous. Currently, less research has been done in modeling imprecision and uncertainty in conceptual data models and design of databases. In this paper, based on fuzzy set and possibility distribution theory, different levels of fuzziness will be introduced into the IFO data model, and the corresponding graphical representations are given. IFO data model is then extended to the fuzzy IFO data model, denoted IF_2O. In particular, we provide the approach to mapping an IF_2O model to a fuzzy relational database schema.

Keywords: conceptual data modeling; database design; fuzzy data; fuzzy relational databases

INTRODUCTION

A major goal for database research has been the incorporation of additional semantics into data models. Databases have gone through the development from hierarchical and network databases to relational databases. As computer technologies move into nontransaction processing, such as CAD/CAM, knowledge-based systems, multimedia, and Internet systems, many feel the limitations of relational databases in these data-intensive applications. So, some nontraditional data models for databases, such as conceptual data models, for example, ER/EER (Chen, 1976), UML (Siau & Cao, 2001), and IFO (Abiteboul & Hull, 1987), object-oriented data model, and logic data model, have been proposed. Conceptual data models can capture and represent rich and complex semantics at a high abstract level (Chan, Wei & Siau, 1993; Fong, Karlapalem, Li & Kwam, 1999; Halpin, 2002; Shoval & Frumermann, 1994; Siau, 1999). Various conceptual data models have been used for conceptual design of databases. For example, the relational databases were designed by first developing a high-level conceptual data model, the ER model, and then the developed conceptual model was mapped to an actual implementation.
(Teorey, Yang & Fry, 1986). As to the IFO model, it was extended into a formal object model, $IFO_2$, and then the $IFO$ model was mapped into object-oriented databases in Poncelet, Tesseire, Cicchetti, and Lakhal (1993).

However, information is often imperfect in real-world applications. Therefore, different kinds of imperfect information have been extensively introduced into databases (Yazici & George, 1998). There have been some attempts to classify various possible kinds of imperfect information, although there are no unified points of view and definitions. But inconsistency, imprecision, vagueness, uncertainty, and ambiguity are viewed as the basic kinds of imperfect information in database systems (Bosc & Prade, 1993). Instead of giving the definitions of the imperfect information, we explain their meanings. Inconsistency is a kind of semantic conflict, meaning the same aspect of the real world is irreconcilably represented more than once in a database or in several different databases. For example, the *age* of George is stored as 34 and 37, simultaneously. Information inconsistency usually comes from information integration. Intuitively, the imprecision and vagueness are relevant to the content of an attribute value, and it means that a choice must be made from a given range (interval or set) of values, but we do not know exactly which one to choose at present. In general, vague information is represented by linguistic values. For example, the *age* of Michael is a set $\{18, 19, 20, 21\}$, a piece of imprecise information, and the *age* of John is a linguistic old, a piece of vague information. The uncertainty is related to the degree of truth of its attribute value, and it means that we can apportion some, but not all, of our belief to a given value or a group of values. For example, the possibility that the *age* of Chris is 35 right now should be 98%. The random uncertainty, described using probability theory, is not considered in this paper. The ambiguity means that some elements of the model lack complete semantics leading to several possible interpretations. Generally, several different kinds of imperfection can coexist with respect to the same piece of information. For example, the *age* of Michael is a set $\{18, 19, 20, 21\}$, and their possibilities are 70%, 95%, 98%, and 85%, respectively. Imprecision, uncertainty, and vagueness are three major types of imperfect information and can be modeled with possibility theory (Zadeh, 1978). Many of the existing approaches dealing with imprecision and uncertainty are based on the theory of fuzzy sets.

Fuzzy information has been extensively investigated in the context of the relational model (Buckles & Petry, 1982; Ma, Zhang & Ma, 1999; Ma & Mili, 2002; Prade & Testemale, 1984). Current efforts have been concentrated on fuzzy object-oriented databases and some related notions, such as class, superclass/subclass, inheritance, and so forth, are extended (Bordogna, Pasi & Lucarella, 1999; Cross, Caluwe & Vangyseghem, 1997; Dubois, Prade & Rossazza, 1991; George, Srikanth, Petry & Buckles, 1996; Gyseghem & Caluwe, 1998; Ma, 2005; Ma, Zhang & Ma, 2004). However, less research has been done in modeling fuzzy information in the conceptual database model. It is particularly true in developing design methodologies for implementing fuzzy databases (Ma, Zhang, Mili, & Chen, 2001). In Chaudhry, Moyne, and Rundensteiner (1999), the fuzzy relational databases were designed by using the fuzzy ER model proposed in Zvieli and Chen (1986). In this paper, fuzzy information is represented via the relational data-
Aiding Maintenance of Database Applications Through Extracting Attribute Dependency Graph
Kaiping Liu, Hee Beng Kuan Tan and Xu Chen (2013). Journal of Database Management (pp. 20-35).
www.igi-global.com/article/aiding-maintenance-of-database-applications-through-extracting-attribute-dependency-graph/84067?camid=4v1a

Query Expansion by Taxonomy
www.igi-global.com/chapter/query-expansion-taxonomy/20359?camid=4v1a