Chapter III

State of the Art in Fuzzy Database Modeling

On occasion, the term imprecision embraces several meanings that we should differentiate. For example, as you saw in Chapter II, the information you have may be incomplete or fuzzy (diffuse or vague), you may not know whether it is certain (uncertainty), perhaps you are totally ignorant of the information (unknown), you may know that the information cannot be applied to a specific entity (undefined), or you may not even know whether the data can be applied to the entity in question (total ignorance or a value of null) (Umano & Fukami, 1994). Each of these terms depends on the context in which it is applied.

The management of uncertainty in database systems is a very important problem (Motro, 1995), as the information is often vague. Motro states that fuzzy information is content-dependent, and he classifies it as follows:

- **Uncertainty**: It is impossible to determine whether the information is true or false. For example, “John may be 38 years old.”
- **Imprecision**: The information available is not specific enough. For example, “John may be between 37 and 43 years old,” “John is 34 or 43 years old” (disjunction), “John is not 37 years old” (negative), or even a simple unknown.
• **Vagueness**: The model includes elements (predicates or quantifiers) that are inherently vague, for example, “John is in his early years” or “John is at the end of his youth.” However, after these concepts have been defined, this case would match the previous one (imprecision).

• **Inconsistency**: It contains two or more pieces of information that cannot be true at the same time. For example, “John is 37 and 43 years old, or he is 35 years old”; this is a special case of disjunction.

• **Ambiguity**: Some elements of the model lack complete semantics (or a complete meaning). For example, “It is unclear whether the salaries are annual or monthly.”

Zadeh (1965) introduces the fuzzy logic, as explained in Chapter I, in order to deal with this type of data. Traditional logic, because it is bi-valued, can operate only with concepts such as yes or no, black or white, true or false, or 0 or 1, which allow for a very limited knowledge representation. Although other logics take more truth values, namely multivalued logics (see the “Imprecision Without Fuzzy Logic” section in Chapter II), fuzzy logic is one extension that takes endless truth levels (or degrees), associating the concept of membership degree or truth degree in an interval [0,1] within the fuzzy logic theory.

Fuzzy databases have also been widely studied (see Chapter II), with little attention being paid to the problem of conceptual modeling (Chaudhry, Moyne, & Rundensteiner, 1999). This does not mean that there are no publications, however, but that they are sparse and have no standard. Therefore, there have also been advances in modeling uncertainty in database systems (Buckles & Petry, 1985; Kerre & Chen, 1995; Chen, 1998; Yazici & George, 1999) including object-oriented database models (Van Gyseghem, de Caluwe, & Vandenberghe, 1993; George, Srikanth, Petry, & Buckles, 1996; de Caluwe, 1997; Bordogna, Lucarella, & Pasi, 1999; Yazici and George, 1999).

At the same time, the extension of the ER model for the treatment of fuzzy data (with vagueness) has been studied in various publications (Zvieli & Chen, 1986; Ruspini, 1986; Vandenberghe, 1991; Chaudhry, Moyne, & Rundensteiner, 1994, 1999; Chen & Kerre, 1998; Chen, 1998; Kerre & Chen, 2000; Vert, Morris, Stock, & Jankowski, 2000; Ma, Zhang, Ma, & Chen, 2001), but none of these publications refer to the possibility of expressing constraints by using the tools by fuzzy sets theory. In Kerre and Chen (1995), you can find a summary of some of these models.
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