Chapter IV
Handling Bipolar Queries in Fuzzy Information Processing

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ABSTRACT
The chapter advocates the interest of distinguishing between negative and positive preferences in the processing of flexible queries. Negative preferences express what is (more or less, or completely) impossible or undesirable, and by complementation, they specify flexible constraints restricting feasible or tolerated values. Positive preferences are less compulsory, and rather express wishes; they specify attribute values that would be really satisfactory. Because they are often expressed independently, negative and positive preferences may be inconsistent. Consistency is then restored by giving priority to negative preferences, since they express genuine constraints. The chapter discusses the handling of bipolar queries, that is, queries involving negative and positive preferences, in the framework of possibility theory. Both ordinary queries expressed in terms of flexible requirements and case-based queries referring to examples and counterexamples are considered in this perspective.

INTRODUCTION
Flexible queries have aroused an increasing interest for many years in the database literature (Bosc & Pivert, 1992; Christiansen, Larsen, & Andreasen, 1997; Larsen, KacpryK, Zadrozny, Andreasen, & Christiansen, 2001), and the fuzzy set-based approach to this problem, introduced about 25 years ago, has been developed both at the theoretical and the practical levels through many works (e.g., Bosc & Kacprzyk, 1995; Petry, 1996). For recent references, see De Caluwe and De Tré (2007) and Galindo, Urrutia, and Piattini (2006). See also the overview chapter by Kacprzyk, Zadrozny, De Tré, and De Caluwe in this book.

In almost all of these works, flexible queries are generally thought of in terms of conjunctions of constraints restricting possible values of attributes. By flexible queries, we mean that these constraints could be fuzzy or prioritized. Fuzzy constraints were introduced by Zadeh (1978) as fuzzy restrictions, induced by natural language
statements and described by membership functions understood as possibility distributions. In Zadeh’s view, possibility refers to the idea of feasibility, and fuzzy constraints can be viewed as a kind of preference profile: values associated with degree 1 are fully feasible, while values with degree 0 are completely rejected; the smaller the degree, the less acceptable the value. The degree of feasibility of a solution to a set of fuzzy constraints is the degree of feasibility of the least satisfied one (Dubois, Fargier, & Prade, 1996b).

The status of a possible solution with respect to a (crisp) prioritized constraint is understood as follows: if it satisfies the constraint, it is fully feasible; if it violates the constraint, it is feasible only to an extent that depends on the strength of the priority attached to the constraint. The feasibility of a solution that violates a prioritized constraint is all the lesser as it has a higher priority. A fuzzy constraint can then be viewed as a collection of nested prioritized constraints (Dubois et al., 1996b), the support of the fuzzy set having maximal priority and its core having minimal priority.

Queries expressed by fuzzy constraints correspond to “negative” preferences of users, in the sense that their complements define fuzzy sets of values that are rejected as being unacceptable. These constraints should be combined conjunctively, thus acknowledging the fact they are constraints. However, there is another type of preference qualified as “positive” in the following. These preferences do not express constraints, but only desires, wishes, and recommendations that are more or less strongly suggested. The satisfaction of some of these desiderata should give some bonus to the corresponding solutions (provided that they also satisfy the constraints, if any). Wishes are not seen as compulsory and can be combined disjunctively.

More recently, Benferhat, Dubois, Kaci, and Prade (2002a, 2006) have proposed and developed a bipolar possibilistic logic framework for preference modeling. On the one hand, prioritized logical formulas (weighted in terms of necessity degrees) are used for expressing constraints whose priorities are more or less high, which thus delimits the fuzzy set of solutions compatible with the constraints. On the other hand, other formulas, weighted in terms of a “guaranteed possibility” function, express the minimal level of satisfaction reached if the solution under concern lies in some subsets of interpretations. The second type of formula corresponds to a “positive” assessment of what is wished, while the first type expresses what is allowed, and rather reflects the result of “negative” preferences (what is rejected defines, by complementation, what may be acceptable). The consistency of the two types of preferences requires that the fuzzy set of interpretations that have some guaranteed satisfaction level be included in the fuzzy set of the interpretations compatible with the constraints.

This chapter offers a discussion of the idea of bipolarity in flexible querying. Two types of queries are considered. One section considers queries (e.g., looking for an apartment) involving both fuzzy constraints (e.g., “not too expensive” is a constraint, since the user cannot afford to pay an overly expensive fare) and fuzzy recommendations (e.g., preferably “near the train station”). Another section studies a type of bipolar querying, namely case-based querying. In this case, the query is evaluated both on the basis of the similarity to examples of what is looked for, and on the basis of the dissimilarity w.r.t. counter-examples. Let us first present basic notions required for the bipolar representation of preferences.

**BIPOLAR REPRESENTATION OF PREFERENCES**

This section provides a tutorial introduction to bipolar representations in the setting of possibility theory. In this chapter, only preference representation is considered in detail. The reader is referred to Dubois and Prade (2006) for an introductory discussion on the different types of bipolarity and to special issues (Dubois & Prade, in press) for more detailed studies of various points of view on bipolarity and various applications.
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