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NOT ALL FUZZY SET OPERATIONS HAVE WEAK HOMOMORPHIC RANDOM SET COUNTERPARTS

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13. ABSTRACT *(Maximum 200 words)*

This paper is a further contribution to the problem of determining which fuzzy set operations are most appropriate for modeling a given situation.

In review, a choice function, as defined by the author, is a mapping from the class of all fuzzy subsets of a given base space into the class of all random subsets of the same space such that any fuzzy set corresponds to some equivalent random set, where equivalence is with respect to membership function and one point coverage function, respectively. This, in turn, induces an equivalence class relation over the class of all random subsets of the given space. In previous work, a number of characterizations have been obtained for these fuzzy set and ordinary (and hence, random) set operations which have weak (i.e., up to the equivalence described above) homomorphic correspondence, relative to certain families of choice functions and joint distributions of random sets. In summary: 1. It has been demonstrated that all ordinary set operations have natural fuzzy set extensions which lead to weak homomorphic representations. Specific constructions of these operations have been exhibited. 2. Most commonly used fuzzy set operations can be shown to arise as both multivalued logical extensions of and weak homomorphic (or homomorphic-like) images of ordinary set operations. These include: all classes of intersections and unions, and more generally, all classes of Cartesian products and sums, in the forms of triangular norms and conorms, respectively; all combinations of these operations with possibly subtractive complementation, for certain classes of triangular norms and conorms; various relations between fuzzy sets including subsetting, projections, and conditioning and sectioning; and many functional and relational transforms of fuzzy sets.

Thus, it had been conjectured that all fuzzy set operations possess some weak homomorphic counterpart within ordinary set operations. In this paper it is shown that this is not at all the case. By judicious use of the above mentioned characterization theorems, a large class of counter-examples may be constructed. The essential idea here is to begin with some ordinary set operation which leads to many distinct fuzzy set extensions. Then it is shown that, in general, some of these fuzzy set operations, no matter which choice function family is used, cannot be placed in a weak homomorphic relationship to the original ordinary set operation. Specific examples are obtained for the particularly important cases of unary functional composition operations on fuzzy set membership functions and certain simple binary fuzzy set operations.

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