

Research on fuzzy structures and approximate reasoning in Salerno, Italy

Antonio Gisolfi obtained his Doctorate of Cybernetics in 1977 and, since 1983, is an associate professor at the Department of Informatics of the University of Salerno. He started his research work with studies on the theoretical background of image processing and subsequently he has explored, in over sixty papers, many application fields. Subsequently, the properties of an algebraic fuzzy structure aiming at describing imprecise reasoning were investigated and currently a group of researchers led by Dr. Gisolfi are working on the relationships between the structure and some interrelated fields.

In (1,2) it is shown how the paths of C-calculus and fuzzy theory are interwoven. In fact, starting from C-sets and C-calculus which were originally proposed to study some problems of pattern analysis and processing of signals (3,4) fuzziness is brought into C-calculus and the properties of the resulting C-fcalculus are investigated. The main idea in C-calculus is to consider the two distinct roles played by the figures in a number, i.e. value and position, and to use them for defining appropriate "composite" sets (C-sets, for short) and related operations. Afterwards, the attention is focused on the theory of approximate reasoning and it is shown how C-fcalculus can be regarded, in some cases, as a possible alternative to the theory of AR. It is worth emphasizing that the basic difference between the C-fcalculus and the fuzzy logic is the inherent parallelism of our structure. This fact allows direct comparisons among the elements and moreover one gets remarkable data compression.

In (5) the algebraic structure is implemented in Prolog and an example regarding medical diagnoses is illustrated. The system runs on IBM-PCs and compatible. In this way we have got a solution to the problem of uncertainty modeling as regards the expert systems environment. However, the usefulness of the prototype is restricted to problems where fuzzy items derive from other fuzzy ones. In these situations "a priori" knowledge is available that connecting some properties leads to other properties and the prototype appears to be a well-suited tool for uncertainty modeling.

Subsequently, we have described (6) how a fuzzy-oriented methodology can be successfully used to build an expert system able to perform chemical and physical analyses of plantations. Particular attention is placed on the management of linguistic variables: we show how a restricted class of fuzzy numbers (flat numbers) represent a good choice to handle appropriately the linguistic entities.

In (7) we aim at extending the operations of the structure described in (1) in order to cope with classification problems. The theoretical aspects are emphasized to give an adequate background to the possible applications. Then, the structure is implemented in Prolog and the resulting system represents an inference tool whose natural range of applicability are classification problems which are characterized by diffused features (e.g. pattern, size, color) and instances of such objects are plancton, sponges, archaeological remains. A subsequent work (8) proposes an algebraic approximation to the problem of generating appropriate classifications in a universe of discourse in which the characteristics of the elements are defined through attributes whose values are linguistic labels. Classifications are generated by means of operations between ordered strings induced by fuzzy attributes. Moreover, a heuristic measure, based on the concept of statistical variance, is used in order to evaluate the potential relevance of

each attribute with respect to generated classifications. With a slight modification, this heuristic can also be used to evaluate the potential relevance of sets of attributes (9). Moreover, it can be utilized to obtain decision trees by selecting the attribute having the greatest potential relevance and in such way the attributes "nought" and "don't care" can be discarded.

Finally, we are presently investigating possible relationships between the algebraic fuzzy structure and the theory of Intelligent Tutoring Systems (ITS) (10). By adopting a fuzzy structure defined on a universe in which the characteristics of the elements are defined by attributes whose values are linguistic labels, we classify student's answers according to fuzzy attributes, on which the tutor wants to focus his investigation about the student's behavior. We are now seeking collaboration with other researchers to investigate other facets of the above-mentioned problems and develop new techniques in other application fields.

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