Evolving Optimal Fuzzy-Connective-Based Hierarchical Aggregation Networks Using Genetic Algorithms

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Abstract. Multilayer fuzzy connective-based hierarchical aggregation networks provide a flexible and intuitive approach to decision analysis. This approach simulates the decision-making processes performed by humans, and the results can be interpreted as a set of rules with which to fashion an abstract model of the problem. Identifying the relative importance of the criteria helps to identify redundancies that do not contribute to the decision-making process. However, a gradient-based learning approach tends to generate local solutions, and requires the aggregation function to be continuous and differentiable. This study proposes a GA-based learning approach to identify the connective parameters, exploiting the global exploration ability of GAs to improve the quality of solutions. This approach does not require gradient information, making it applicable to both differentiable and nondifferentiable aggregation functions. The benefits of this method were demonstrated using eight datasets with different characteristics. Statistical analysis of the experimental results confirms that the proposed approach outperforms the gradient-based learning approach, generating more accurate estimates for both generalized mean and gamma operators. The proposed approach is well suited to a broad range of fuzzy aggregation connectives, which further expands its applicability.

Keywords: Fuzzy connectives, Multilayer hierarchical aggregation, Genetic algorithms (GAs), Decision analysis

1. Introduction. Decision analysis is an important area of research, involving the aggregation of information according to multiple criteria at several levels simultaneously. Researchers have proposed a variety of fuzzy set connectives for the purpose of aggregating information, according to the specific applications involved. Many decision-making situations require a degree of compensation [1], and generalized mean operator and gamma operator can be applied specifically to such situations.

Krishnapuram and Lee [2,3] proposed a fuzzy connective-based aggregation network capable of aggregating and propagating information hierarchically, according to the degree of satisfaction. Their gradient-based learning approach systematically identifies the parameters associated with generalized mean and gamma operators at each node. It is also capable of determining the nature of the connectives and interpreting the resulting network as a set of rules with which to fashion an abstract model of the problem. Identifying the relative importance of criteria can help to identify redundancies that do not