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FUZZY INTERPOLATIVE REASONING METHODS AND ALGORITHMS FOR THE SPARSE FUZZY RULE

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Abstract. *In this paper, a new fuzzy interpolative reasoning method is proposed for the sparse rule bases by using the highest points and slopes of the antecedent and consequent fuzzy sets. The proposed fuzzy reasoning methods are not only suitable for the four kinds of fuzzy sets in inference rules, but also can guarantee the convexity and normality of the reasoning consequence. Furthermore, the computation is simpler than the existing fuzzy interpolative reasoning methods.*
Keywords: Fuzzy interpolative reasoning, Sparse rule base, Highest point, Slopes

1. **Introduction.** It is well known that the number of fuzzy rules in fuzzy rule-based systems can significantly affect the performance of rule-based systems. The more sparse the fuzzy rule bases, the faster the rule-based systems in execution. Thus, several approximate reasoning methods based on sparse fuzzy rule bases have been proposed in [1-8]. In those sparse rule-based systems, the rule bases are incomplete, i.e., there are many empty spaces between the membership functions of the antecedents in the inference rules. When the membership function of the observation occurs on the empty space, no rule will be fired and no consequence is derived [6]. In order to cope with this problem, Koczy and Hirota [2,3] presented a linear interpolative reasoning method to solve the "Tomato classification" problem presented in [5-7]. It can be seen that the method presented in [2,3] is very useful fuzzy reasoning algorithms for the sparse rule-based systems.

Yan et al. [6] analyzed Koczy and Hirota's interpolative reasoning method [2,3] and pointed out that the reasoning consequences sometimes become abnormal fuzzy sets. Moreover, they proved that the statement "If fuzzy rules $A_1 \rightarrow B_1$, $A_2 \rightarrow B_2$ and the observation A^* are defined by triangular membership functions, the interpolated conclusion B^* will also be a triangular type" mentioned in [2,3] is not correct. Furthermore, Yan et al. also hope that someone can develop a new interpolative reasoning method which can guarantee that the interpolated conclusion will also be triangular-type observation. From the analytical result of [6], it can be concluded that the reasoning consequence sometimes become abnormal fuzzy set by using Koczy and Hirota's interpolative reasoning method [2,3] due to the fact that their method only interpolated the bottoms of the fuzzy sets but ignored the interpolations of the highest points of the fuzzy set in the interpolative reasoning process. On the basis of [6], Hisao et al. [7] proposed a kind of interpolative reasoning method, it can guarantee that the statement "If fuzzy rules $A_1 \rightarrow B_1$,