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NOTES ON DEFINING FUZZY SETS IN THE CREATED INFERENCE SYSTEM WITH PROBABILISTIC-FUZZY KNOWLEDGE BASE

Abstract: In the paper two methods of defining fuzzy sets are considered: the method of standard membership functions and grades of memberships in disjoint intervals of variables space. An empirical example is discussed. The Root Mean Squared Error and the time of rules generation are compared.

Fuzzy if-then rules are an appropriate form of describing subjective uncertainty results from lack of knowledge and objective uncertainty results from characteristics of objects. On the other hand, the uncertainty due to randomness can be described using the theory of probability. It should be clear that tools which use fuzzy sets and probability can analyze complete uncertainty of real problems. One example, mentioned in [1], is an inference system with probabilistic-fuzzy knowledge base. In the mentioned system knowledge is saved in the weighted fuzzy rules, where the weights constitute marginal probabilities of the events in the antecedents and conditional probabilities of the events in the consequents. The algorithm of automatic knowledge base extraction is a modification of the Apriori algorithm, which is typically used for discovering association rules in the database. The algorithm extracts the most important and matching linguistic rules by assumption of minimum support as a minimum joint probability of the events in the rules. If minimum support equals zero, then the rules present total probabilistic distribution of the fuzzy events, otherwise the rules present probabilistic distribution, which is the best matching to a variables universe.

In the methodology of system creation, the universe of quantitative variables is discretized on K disjoint intervals of variable values, correspondingly $a_n = (a_n^1, ..., a_n^k, ..., a_n^K)$ for input variable x_n and $b = (b^1, ..., b^k, ..., b^K)$ for output variable y. The fuzzy sets are defined by grades of membership of the disjoint intervals to fuzzy sets: $\mu_{A_j^n}(a_n^k) \in [0,1]$ for n-th input variable x_n and $\mu_{B_j}(b^k) \in [0,1]$ for output variable y, where A_j^n and B_j constitute fuzzy sets for inputs and an output. Often, the question is: why was the traditional Zadeh's definition of fuzzy sets [2] not used in the form of membership function $\mu : \aleph \to [0,1]$, where $\aleph$ is a universe of variable?

The problem is analyzed by using an example of a wind speed identification process. Training data include information about the wind speed collected during 8 days. In the paper, an approach to prediction $v(t)$ at time t as calculations on the basis of the three pervious measurements is proposed. To describe linguistic variables, seven fuzzy sets are used. Modeling universes of variables to interval [0,1] is executed by using triangular and trapezoid membership functions or their discretization to grades of membership for the 30 disjoint intervals. Two modeling approaches have been compared using both methods of defining fuzzy sets (Fig. 1). The time of model generation has also been considered (Fig. 1).

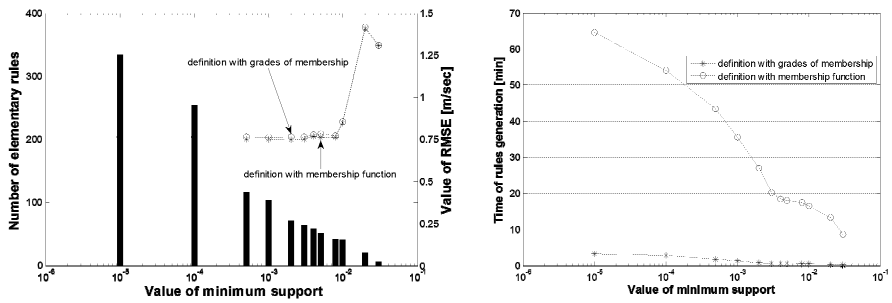

Fig. 1. Comparison of different methods of defining fuzzy sets.

As a result, the number of the elementary rules in knowledge base is almost the same in both cases. Moreover, when comparing the results of prediction, values of RMSE (Root Mean Squared Error) are on the same levels when we use membership functions and grades of membership.

The described fuzzy system was implemented using Matlab structural programming. Unfortunately, the time of rules generation using membership functions is not favorable. It is because, if membership functions are used, the algorithm must be written in an iterative way. But, if grades of membership are used, the algorithm can be vectorized. The disadvantage of the solution is more memory usage, which is not so important when using current hardware.

The article proves that the use of grades of membership for disjoint intervals is an adequate method and it can still be used for defining fuzzy sets in an inference system with probabilistic-fuzzy knowledge base.

REFERENCES

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