A LITERATURE STUDY OF FUZZY RULE BASED CLASSIFIERS

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Abstract - *Fuzzy Rule-Based Classification System (FRBCS) have the potential to provide alleged explicable classifiers, i.e. Classifiers which can be introspective, understood, valid and enhanced by human experts by depending on fuzzy-set based rules. A significant issue in designing the fuzzy rule-based classification system is the development of fuzzy if-then rules and the membership functions. Knowledge acquisition is a search problem in high dimensional space in which each issue relates to a rule set and membership function and the system behavior. Several methods are available for generating and learning fuzzy classification rules from the data. Subsequently, many techniques have been presented in the literature for optimal definition of fuzzy rules by using optimization algorithms. In this paper, it reviewed that different optimization techniques are available for design of optimal membership functions and rule generation.*

Keywords: **Classification system, Fuzzy rule-based, optimal membership functions and rule generation.**

I. INTRODUCTION

Complex engineering problems have dropped the procedure of conventional approaches and improved the attention towards computational intelligence methods such as fuzzy logic, artificial neural networks and so on. Over the era, hybrid approaches have increased more considerable attention and a well-known approach is the hybridization between fuzzy logic and GA and which results in genetic fuzzy systems. A system that can be defined as a model structure has the form of FRBSs. Fuzzy rule based classification system are well known and useful machine learning tools due to its ability to develop an interpretable model for the user. The fuzzy rule search space in exponential manner that leads to affect FRBC's inductive learning.

The FRBCS engages a large number of extensive applications that are efficiently considered for supporting the requirements of intelligent support. Real-time issues in various fields, similar to classification, classical network optimization, pattern recognition, pricing prediction system, travel choice behavior models, disease prediction, robotics based on behavior, detection of rice quality, etc., implement FRBCs to accomplish optimized learning rule.

The main advantage of the fuzzy rule-based classifier is the potential ability of integrating human expert knowledge into the decision making process. To produce and study the classification rules of the fuzzy system, different techniques, such as simple heuristic and Meta heuristic measures, clustering approaches, Genetic Algorithm (GA), and neuro-fuzzy techniques, are available. Moreover, many heuristic and meta-heuristic algorithms, such as Particle Swarm Optimization (PSO), Firefly, Simulated Annealing Method, Greywolf Optimizer, Artificial Bee Colony optimization, and so on, are developed depends on the

behavior of biological systems in nature. The hybrid fuzzy methods are projected in for mining a compact rule base. It represents only the rule set in the genetic population and so it failed to model the fuzzy system clearly. In the fuzzy system, the membership function and rule set are co-dependent, and so it should be designed at the same time.

II. SURVEY ON FUZZY RULE BASED CLASSIFIERS

The AFS fuzzy set theory [1],[11] which facilitates an important step on how to convert the information in databases into the membership functions and their fuzzy logic operations, by taking both fuzziness (subjective imprecision) and randomness (objective uncertainty) into account, and fuzzy entropy as an attribute selection to generate the AFS classifier (decision tree).
Introduced the fitness Index to estimate the optimal threshold δ, which is used to control the design of the AFS decision tree and a level of detail being captured by the tree and considered fuzzy sets (coherence membership functions) and the underlying logic operators generated by the AFS to eliminate potential subjective bias in the construction of tree. Furthermore, a method designed to create a classifier based on fuzzy rules using the membership functions and the approach is applicable even for the datasets with mixed attributes.

An approach to optimize the membership functions and the rules [2] has been proposed an Adaptive Genetic Fuzzy System (AGFS) for the classification of medical data. The approach proposed to 1) generating rules from data and optimized rules selection depends on genetic algorithm and to explain the exploration problem in algorithm using systematic addition, 2) a simple technique for scheming of membership function and discretization, and 3) formulating a fitness function by allowing the frequency of rules occurred in the training data. Based on the qualitative, quantitative and comparative analysis evaluated the efficiency of the suggested classifier approach. AGFS is more applicable for high dimensional data.

A new classifier approach known as BFC – Bat based Fuzzy classification [3] has been proposed by unifying bat algorithm with fuzzy set and it is used to optimize the rules and whereas the fuzzy system classifies the test data. The objective is to reduce the complexity in designing and discretizing the membership function and the design of fitness function based on the frequency of occurrence of rules in training data. Eventually, the performance is evaluated based on quantitative, qualitative and comparative analysis.

A new fuzzy system is presented [4] Brain Storm Fuzzy System (BSFS) is developed for data classification by combining the traditional fuzzy system with Exponential Brain Storm Optimization algorithm (EBSO) and uniform distribution-based approach. The objective is developed to evaluate the rule set using length of the rule, class distribution and matching capability.

A novel hybrid Ant Bee Algorithm [5] is proposed to address the accuracy interpretability tradeoff in the design of fuzzy expert system for sample classification. In ABA, the rule set is represented using integer numbers and evolved using ACO. The values of membership function use floating point numbers and are evolved using ABC simultaneously along with the rule set. The accuracy of the classification is improved, as the approach has low false positive rate and high discrimination power.

A hybrid system, Brain Genetic Fuzzy System (BGFS) [6] is developed for data classification by combining the classic fuzzy system with the exponential genetic brain storm optimization (EGBSO) algorithm. The new algorithm is developed for designing fuzzy membership functions by integrating the exponential weighted moving average (EWMA) model, BSO and GA. The performance of the suggested method is evaluated using sensitivity, specificity and accuracy.

A novel algorithm known as Genetic Swarm Algorithm [7] by combining Genetic Algorithm and Particle Swarm Optimization algorithm to obtain the optimal set of rules and to adjust the membership function. The suggested approach represents rule set using binary strings and the values of membership function using floating point numbers. Advanced and problem specific genetic operators are suggested to improve the convergence of GSA and classification accuracy.

For the performance improvement of fuzzy rule-based systems [8] focused on different granulation levels that integrate rule selection and the 2-tuples tuning approach to improve the performance in imbalanced datasets. A positive synergy is formed between the approaches used for data sampling for the modification of algorithm and then creates a genetic programming model that utilizes the linguistic variables in a hierarchical manner. The performance of the proposed approach is evaluated using sensitivity, specificity and accuracy.

Based on complex linguistic data summaries [9], a method for extracting linguistic rules from data sets is proposed, in which, the degree of confidence of linguistic rules from a data set can be explained by linguistic quantifiers and its linguistic truth from the fuzzy logical point of view. Genetic algorithm is used to optimize the number and parameters of membership functions of linguistic values, optimized linguistic rules have higher fuzzy linguistic quantifier and linguistic truth.

A rule-based CCACO [10] is proposed for Fuzzy System design optimization. For a given number of rules, the CCACO is used to optimize all of the free parameters in the FS to achieve high learning accuracy. In the CCACO, a single fuzzy rule forms a population, and different populations cooperate to form a complete FS. The simulation results show that the CCACO outperforms the GA, PSO, continuous ACO algorithms, and evolving NFSs used for comparison. In particular, the comparison with different continuous ACO algorithms using a single population shows the advantage of introducing the multi population and cooperative structure into continuous ACO. In addition, the comparison with PSO algorithms using the same multi population topology shows the advantage of using the new continuous ACO algorithm for solution generation and update. In the future, the CCACO can be applied to multi objective FS design problems for optimization performance improvement.

III. CONCLUSION

Fuzzy system is broadly applied for classification since it has the additional beneficial of providing flexibility and evaded learning time as compared with other classifiers like, neural network and support vector machine. Still the fuzzy system has high-quality application, it found complex in its designing procedure like, rule base and membership function designing where, domain experts' knowledge is required even though the significant data is available. These two steps should be automatically performed

to avoid the requirement of expert's knowledge of data in fuzzy classification system. This paper analyzes the challenge in the designing of membership function and the optimized rule set.

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