



A Review On: Generation of Automatic Fuzzy Rule Base from Numerical Data using Nature-Inspired Approach

Aditi Mittal

Electronics & Comn Engineering, KUK University,
Haryana, India

Abstract- Fuzzy logic provides a foundation for a methodology of computing with words. This provides a framework for modeling the ability of the human mind to manipulate perception. Nature- Inspired methods are currently among the most powerful algorithms for optimization problems. The main objective of this paper is to study various nature inspired techniques used to generate fuzzy rule base from numerical data.

General terms- Soft computing, fuzzy model identification.

Keywords- Fuzzy logic, Cuckoo search algorithm, rule base.

I. INTRODUCTION

Development of complex real-system medals is an important topic in fields of science and engineering. These development models are mostly used for stimulation, identifying the behavior of system and design of controllers. The principles of fuzzy modeling were guided by Zadeh when he gave the concept of membership and published his paper on fuzzy set that gives the birth of fuzzy logic technology [1].

II. FUZZY MODELS

Fuzzy systems are gaining widespread acceptance in a large variety of fields, from engineering to commercial and from broadcasting to artificial intelligence etc[1]. Fuzzy systems provide a scheme to represent the knowledge in such a way that resembles human communication and reasoning. Design of fuzzy model is the task of finding parameters of fuzzy model so as to get the desired behavior. There are two different approaches to design fuzzy models:- knowledge driven and data driven.

In knowledge driven, the design is constructed from the knowledge acquired from experts, while in data driven the input and output data is used for building model.

Tagaki, Sugeno and kang developed the approach for building fuzzy rules from the training data that leads to the foundation of fuzzy modeling or fuzzy model identification. Many optimization techniques as genetic algorithm, swarm intelligence, ant colony optimization etc has been proposed to generate fuzzy rule for numerical data.

III. FUZZY RULE BASED SYSTEMS

A fuzzy rule based system presents four major modules:- fuzzification, inference engine, knowledge base and defuzzification module.

The rule of fuzzification module is to transform the crisp input into fuzzy values. The fuzzy values are sent to interference engine where they are processed into fuzzy domain through the knowledge base supplied by the domain experts. Knowledge base consists of rule base and data base. The rule base characterizes the control goal and control policy of domain experts. The data base contain the sets and membership function defined their semantics. The defuzzification finally transformed the fuzzy domain to crisp domain.

The structure is shown below:-

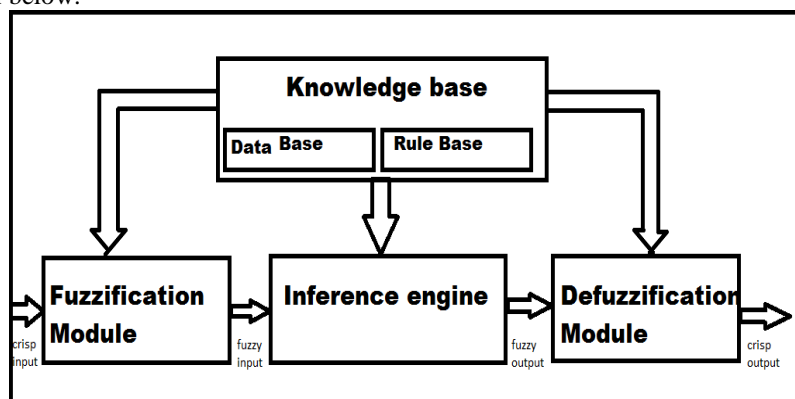


Figure 1:- Fuzzy Rule Base Structure

IV. FUZZY SYSTEMS DESIGNS

The process of fuzzy system design involves the following steps:-

- 1) Identify the input and output variables.
- 2) For these variables generate the membership function and decide their shape i.e. triangular, Z type etc.
- 3) Generate rule base for the system.
- 4) Select the type of interference area, rule composition operator, implication and aggregation operators.
- 5) Decide on a defuzzification technique and generate a crisp control action.

If the performance of the model obtained is not satisfactory, the model structure is modified and the parameters are re-estimated till the performance is satisfactory.

V. RELATED WORK

The various techniques used for Fuzzy Rule Base are discussed below:

A. A firefly optimization approach:

This paper presents a nature-inspired algorithms name Firefly Algorithm (FA) for automatically evolving a fuzzy model from numerical data studied by Shakti Kumar, Parvinder Bhalla and Amarpartap Singh. FA is a meta-heuristic inspired by the flashing behavior of fireflies. The rate and the rhythmic flash and the amount of time form part of the signal system to attract other fireflies.

B. Knowledge extraction from numerical data using BBO approach:

Fuzzy rule base systems are class of knowledge based systems. Two approaches can be found in the literature which are used for rule base generation. In this paper, Shakti Kumar, Parul Narula and Tazeem Ahmed present Biogeography Based Optimization (BBO) for the rule base generation of Mamdani type Fuzzy logic based systems. Biogeography is a study of geographical distribution of biological organisms. It is a burgeoning nature inspired technique to find the optimal solution of the problems. In between solutions according to the fitness of the habitats the results indicates that the BBO is a very promising optimization algorithm for evolving fuzzy logic based systems.

C. A new method for handling fuzzy classification problems using clustering techniques:

Fuzzy classification systems are important applications of the fuzzy set theory. The Fuzzy classification systems can deal with perceptual uncertainties in classification problem. In this paper, Shyi- Ming Chen and Cheng – Hao Yu presents a new method to deal with the iris classification problem based on the concept of fuzzy compatibility relations for finding the cluster centers of training instances. Clustering technique i.e. the proposed method can get a higher average classification accuracy rate to deal with the iris data classification problem than the existing methods

D. Cuckoo search algorithm with application to algorithm trading systems optimization:

Cuckoo search is a nature- inspired metaheuristic algorithm, based on the broad parasitism of some random walk. In this paper, Ahmed S. Tawfik, Amr A Badr, Ibrahim F. Abdel Rahman, gives a modified version where the new solution generated from the exploration and exploitation phases are combined, evaluated and ranked together, rather than separately in the original algorithm, to imposing a bound by best solutions mechanisms to help improve convergence rate and performance.

E. Fuzzy Rule Base generation using biogeography Based Optimization:

Fuzzy based systems are one of the very important class of knowledge based systems. The knowledge in a fuzzy system is embedded in the form of a rule base. In this paper S Kumar, P Bhalla, A Singh uses a BBO approach. BBO was used to enumerate rules corresponding to each data set. They discuss rule extraction for type zero TSK fuzzy systems for battery charger. The approach is very powerful computation tool to deal with NP hard problems. The results indicate that the BBO is very promising optimization algorithm for evolving fuzzy logic based systems.

F. Nature- inspired Metaheuristic Optimization Algorithms:

There are various metaheuristic algorithms which can be used to solve optimization problems efficiently. In this paper Peepthis and Aswathy Ravikumar, uses four types of metaheuristic algorithms such as ACO, Firefly algorithm, Bat algorithm and cuckoo search algorithm were used as the basis for comparison. ACO is based on the interaction between social insects. Firefly algorithm is influenced by flashing behavior of swarming firefly. Cuckoo search uses brooding parasitism of cuckoo species and Bat algorithm is inspired by the echolocation of foraging bats.

G. Fuzzy Model using Memetic Algorithm:

The process of fuzzy modeling or fuzzy model identification is an arduous task. This paper presents the application of memetic algorithms for the identification of complete fuzzy model that includes membership function design for input and output variables and rule base generation from the numerical data set. Savita Wadhawan, Gunjan Goel and Srikant Kaushik applied the algorithms on four bench mark data:-

A rapid Ni-Cd battery charger, the Box and Jenkins Gas furnace data, the iris data classification problem and the wire data classification problems. The comparison of obtained results from MAs and Genetic algorithms bring out the remarkable efficiency of MAs.

H. Classification of iris plant using feed forward neural network:

The primary aim of this paper is to demonstrate the process of developing the artificial neural network based classifier which classifies the iris data base. The problem concerns the identification of iris plant species on the basis of plant attribute measurements. This paper is related to the use of feed forward neural network towards the identification of iris plants on the basis of:- Sepal length, Sepal Width, Petal length and Petal Width.

I. Comparison among five evolutionary- based optimization algorithm:

Evolutionary algorithms (EA) are stochastic search methods that mimic the natural biological evolution and/or the social behavior of species. Such algorithms have been developed to arrive at near-optimum solution to large-scale optimization problems, for which traditional mathematical techniques may fail. In this paper, Emed Elbeltagi, Tarek Hezazy and Donald Grierson compares the five recent evolution – based algorithms: Genetic algorithm, memic algorithm, partical swarm optimization, ant colony optimization and shuffled frog leaping. This study presents sophisticated ideas in a simplified form that should be beneficial to both practitioners and researchers involved in solving optimization problems.

VI. SUMMARY OF AUTOMATIC FUZZY RULE BASE

METHOD	BASED ON	FEATURES
Fuzzy Model Identification	A Firefly Optimization	This successfully generate optimized fuzzy model from training data. The proposed approach was successful validated on two problems. FA generated a fuzzy model is less than 100 iterations with average MSE of 0.008. For classification problem, the stimulation results show that the proposed method evolved fuzzy classification system with high classification rate of 98.66%
Knowledge extraction from numerical data for Mamdani type fuzzy system	BBO Approach (Biography Based Optimization)	The method appears to be very efficient. Performance is compared with other optimization approaches i.e. ACO, PSO, GA based optimization techniques. The result indicates that BBO appears to be most efficient approach to such NP hard problems.
Fuzzy Classification problem	Clustering Technique	This method gives higher average classification accuracy rate to deal with the iris data classification problem. This method is generalized to deal with other classification problems. This will develop an automatic learning mechanism to automatically derive the optimal value of α , β , γ and λ to get a higher average classification accuracy rate for dealing with fuzzy classification problems.
Application to algorithmic trading systems optimization	One rank cuckoo search	By reducing the complexity associated with the use of the ORCS algorithm, and allowing researchers to focus their efforts without worrying about the best operational parameters to use, making ORCS more convenient to use.
Fuzzy Rule Base Generation	BBO (Biogeography Based Optimization Approach)	BBO was applied to successfully extract rule base from numerical data. All rules were extracted from the given data for a TSK type zero system. Its performance is compared with other optimization techniques i.e. ACO, PSO, and GA out of which BBO appears to be more efficient.
Nature inspired Metaheuristic optimization algorithms	Firefly algorithms	From comparison of firefly, bat, cuckoo and ant colony optimization algorithm, firefly algorithm is most efficient one. Time complexity of firefly is lesser than other algorithms. Firefly is used for job scheduling problems. Bat algorithm used in classification of Gene expression data.
Data Driven fuzzy modeling for Sugeno and Mamdani type fuzzy model	Memetic algorithm	The purposed modeling was successfully applied to four well know problems from literature i.e. Ni-Cd battery charger, the Box and Jenkin's gas furnace data, iris classification and wine classification problem. This paper also compares the result obtained from MA and GA's. The flexibility can be increased in terms of no of membership functions for each variable type of membership function and the number of rules.

VII. CONCLUSION

The fuzzy rule base from Numerical data using Natured inspired approach can be improved by using cuckoo search algorithm. Fuzzy systems are gaining wide spread acceptance in a large variety of fields. Fuzzy logic control provides an algorithm which can convert the linguistic strategy based on expert knowledge into an automatic control strategy.

REFERENCES

- [1] Shakti Kumar, Parvinder Kaur and Amarpratap Singh, "Fuzzy model identification: A firefly optimization Approach", International journal of computer application(0975-8887) volume 58 – No.6, November 2012.
- [2] Shakti Kumar, Parul Narala and Tazeem Ahmed," Knowledge extraction from numerical data for the mamdani type fuzzy system: a BBO approach", computational intelligence laboratory , Institute of science and technology Kalawad, Haryana.
- [3] Shyi-Ming Chen and Cheng-Hao Yu," a new method for handling fuzzy classification problems using clustering techniques," international journal of applied science and engineering 2004,1:90-104.
- [4] Ahmed S. Tawfik, Amr A. Bard and Ibrahim F. Abdel-Rahman,"one rank cuckoo search algorithm with application to algorithmic trading system optimization",international journal of computer applications(0975-8887) volume64-No.6,February-2013.
- [5] S.kumar, P.Bhalla and A.singh , "fuzzy rule base generation from numerical data using Biogeography-based optimization" , IE(1) Journal – ET , volume 90,july 2009.
- [6] R.Rajesh, "fuzzy logic control- a quick review",international journal of wisdom based computing, vol(1),2011.
- [7] Deepthis and aswathy ravi kumar , " A study from the perspective of nature inspired metaheuristic optimization algorithms," international journal of computer applications (0975-8887) volume 113- no.march 2015.
- [8] xin- sheyang and suash deb , "engineering optimization by cuckoo search ".
- [9] Harjinder Kaur and Gaganpreet Kaur," Cuckoo search based optimization for multimodal biometrics(signature, speech and palmprint)", international journal of computer applications(0975-8887) volume 107-No. 18, December 2014.
- [10] Savita wadhawan,Gunjan goel and Srikant Kaushik,"Data driven fuzzy modeling for sugeno and mamdani type fuzzy model using memetic algorithm",I.J. information technology and computer science,2013,08,24-37. Published online July 2013 in MECS DOI.10.5815/ijitcs.2013.08.03
- [11] Shrikant vyas and dipti upadhyay," classification of iris plant using feed forward neural network", international refereed journal of engineering and science ISSN(online) 2319-183X, (print) 2319-1821 volume 3, issue 12 (December 2014), PP. 65-69.