

# Machine Learning approaches based on Genetic Fuzzy System

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**Abstract**— Numerous problems can be resolved by genetic fuzzy systems in a variety of application areas. In this study, we attempt to integrate the learning and adapting characteristics of genetic algorithms with fuzzy systems. To identify the most effective alternative approach, we are utilizing optimization methods that combine fuzzy theory and genetic algorithms. Specifically, our paper provides an overview of genetic fuzzy systems, with a focus on genetic fuzzy rule-based systems. This study aims to explore novel strategies for incorporating genetic evolutionary techniques into a fuzzy rule-based system. While machine learning approaches have shown potential in enhancing fuzzy rules, the development of systematic methods for this integration has been lacking until recently. Consequently, machine learning technologies can significantly contribute to the improvement of fuzzy rule systems. In this paper we will try to analyse the new perspective for machine learning concepts.

**Index Terms**— Fuzzy, Genetic Algorithm, Machine Learning.

## I. INTRODUCTION

The term fuzzy means the situation or things which cannot be determined as exactly true or false, in such situation fuzzy logic provide flexibility for representing such situations. In the realm of Boolean logic, the truth value 1.0 signifies the complete truth, while 0.0 signifies the complete falsehood.

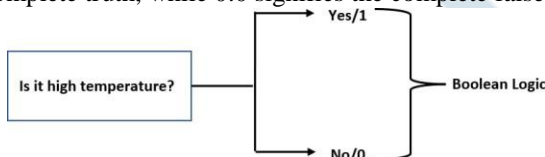


Figure 1. Representation Boolean Logic

In contrast, the fuzzy system does not accommodate precise truth or false values. Rather, fuzzy logic incorporates an intermediate range of values.

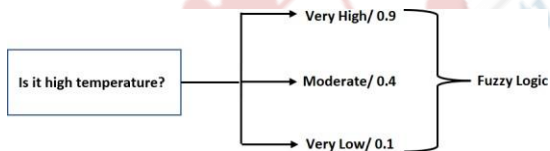


Figure 2. Representation Fuzzy Logic

value that is partially true and partially false.

## II. GENETIC ALGORITHM

Genetic algorithms are algorithms which follows the principle of adaptive heuristic search inspired by natural genetics to evolve solutions for a particular problem. These are intelligent algorithms that employed the random search supported with historical data. These algorithms mostly focus on high quality and accurate solutions for optimization problems.

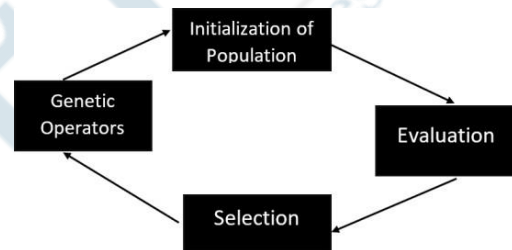
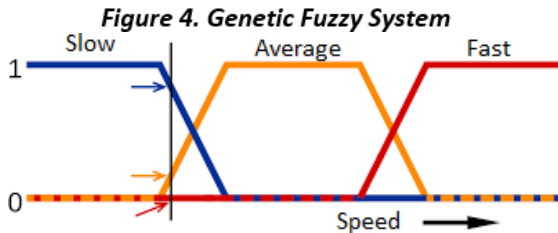
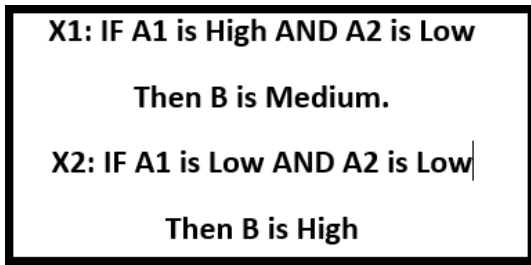


Figure 3. Structure of Genetic Algorithms

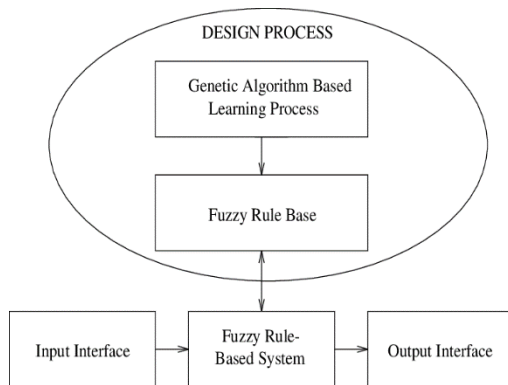
A Genetic Algorithm starts with a randomly generated chromosomes known as population and the advance towards better chromosomes by applying genetic processes. In the depicted diagram, We investigate the manipulation process that involves the utilization of genetic operators to create a new population of individuals. Two specific operators, namely Crossover and Mutation, are employed to generate offspring that replace the existing population. This iterative cycle continues until a predefined number of cycles is reached. These learning processes encompass various complexities, ranging from parameter optimization to acquiring the rule set of a rule-based system. When undertaking the task of learning rules within a rule-based system, numerous possibilities are available for exploration.

**Genetic fuzzy rule-based system:** The Genetic Fuzzy Rule-Based System is a specific subset of fuzzy systems. It incorporates the principles of Genetic Programming and Genetic Algorithms to define its structure and functionality



Fuzzy systems rely on IF-Then conditional statements that are formulated as if A1 then A2, where A1 and A2 represent fuzzy sets.

The set of rules related to fuzzy logic system are called fuzzy rule- based system.

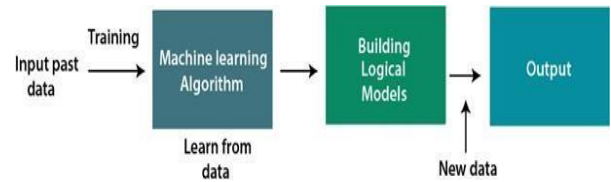


**Figure.5. Genetic Fuzzy System**

The depicted figure illustrates the learning process facilitated by the genetic algorithm, which involves a knowledge base comprising a combination of a database and a rule base. Through the interface, a set of inputs is provided, which undergo processing based on the rules of the fuzzy rule-based system. The system then generates the desired set of outputs through the interface.

### III. MACHINE LEARNING

Machine Learning, a subset of artificial intelligence, is primarily concerned with developing algorithms that enable computers to autonomously learn from data and make predictions. The term "machine learning" was originally coined by Arthur Samuel in 1959. This field empowers machines to automatically enhance their performance through learning from experience and make predictions without relying on explicit programming.

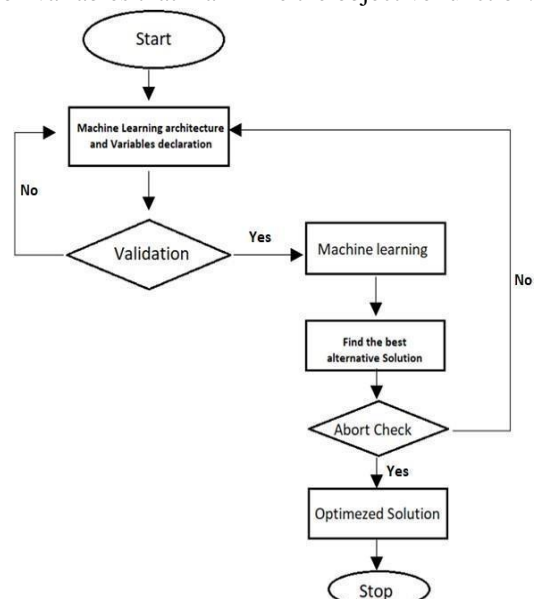


**Figure.6. Machine Learning**

### IV. MACHINE LEARNING APPROACHES BASED ON GENETIC FUZZY SYSTEM:

In order to construct highly performing ML models, this work focuses on optimizing the features. The classical system for addressing these problems is illustrated in the figure. It begins by optimizing the variable values without integer constraints to find the optimal solution. Consequently, this outcome prompts the investigation of two additional subproblems. For each variable, every branch is compared against the upper and lower estimated boundaries of the desired outcome. The subproblems are resolved based on the new evaluation, and the process of branching is repeated iteratively until a solution that meets the constraints is achieved.

Alternatively, heuristic techniques such as genetic algorithms (GA) and evolutionary algorithms are faster and more efficient in comparing the results of computationally intensive problems. Starting with randomly generated individuals, a new generation with modified target values is created. This process continues until a sufficiently good solution is determined. An inheritable algorithm (GA), inspired by biological mechanisms, represents a heuristic approach based on the evolutionary process and serves as an optimization procedure in a dual search space. The objective of this process is to identify the optimal values for the decision variables that maximize the objective function.



**Figure 7. Machine Learning Architecture using GA**

In the above figure we are trying to demonstrate the machine learning methods using genetic algorithm first of all we have defined and declared variables using machine learning architecture, next step we have check the constraints if it has no constraints the algorithm will go back to the initial stage but if it has any constraints then it will go to the learning stage and it will find the best possible different solution. If it meets the termination condition then we have got the optimal solution and if no then will go back to the initial stage.

## V. CONCLUSIONS

This study presents a fuzzy system that incorporates genetic rules, offering both adaptability and machine learning capabilities. To discover the best alternative option, we have used evolutionary algorithms and fuzzy system optimization approaches. This paper gives special attention to genetic fuzzy rule-based system. In this paper we have tried to explore new machine learning approaches and techniques based on genetic fuzzy system.

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