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Using Polygamy Technology with FL, GA and NN On Traffic Lights

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----------ABSTRACT----------

recently, multi agent system was developed intelligent techniques through polygamy with Fuzzy logic (FL), Artificial neural network (NN) and genetic algorithm(GA) therefore, a combination has led to the emergence of Fuzzy Neural Network (FNN) and Genetic Fuzzy System (GFS), and has a hard challenge because these polygamy design of intelligent systems from different aspects. Each agent uses a multi stage process of learning direct, decision making mechanism and update, adapt their knowledge base, Knowing that he mechanisms learning form the basis for adaptive systems. FNN is a has advantages of both fuzzy expert system become capable of learning (fuzzy reasoning) and artificial neural network become more transparent (self-adapting, self-organizing and self-learning). Compared with traditional control methods for traffic signal find better resolution for optimize is a genetic algorithm. The genetic learning process aims at designing and optimizing the knowledge base. The genetic process is the result of the interaction between the evaluation, selection and creation of genetically encoded candidate solutions, which represent the contents of the knowledge base (KB). The traffic signals control, there are a number of diverse criteria or control objectives, such as maximize safety, minimize delays and minimize environment disadvantage.

KEYWORDS:*Fuzzy logic, Fuzzy Neural Network, Genetic Algorithm, genetic fuzzy systems*.

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I. INTRODUCTION

Increase the owners of cars and population expansion leading to an increase in intersections and the rate of the vehicles on the roads. Then a danger of the vehicles has appeared and they began Collision and left many victims. Human mind began thinking of way that can decrease the accidents by organizing the movement of vehicles and pedestrians on the roads. Then it came the birth of the first scientific method, it was the traffic light. conventional methods for traffic signal control but most of them sometimes fail to deal efficiently with the complex, time-varying traffic conditions and controller can't satisfy real-time character for traffic signal [8].They are modelled based on the preset cycle time to change the signal without any analysis of traffic situation. It gives the orders to drivers by three lights, red, orange, and green. The red Colour means the Drivers of Vehicles must stop. The orange Colour means the Drivers of Vehicles must ready that the colour will change from red to green. The green Colour means the Drivers of Vehicles must go. The automotive industry has flourished and the national product output increased to states .The level of income of the individual increased and became one of ten people has a vehicle or perhaps more. The roads are filled with pedestrians and vehicles, and the traffic light became unable to organize them because of congestion. So this congestion has forced some states to give up the traffic light in the congested places and resorting to build tunnels and elevated bridges .This solution faced many obstacles in some states and it cannot be applied inside them. And they are: Firstly, it needs a lot of money that it is costly to their budget. Secondly, it is very dangerous in states that are known of earthquakes .Thirdly, it is very dangerous in states that their roads are above natural sites such as rivers. But we can overcome these obstacles by developing the traffic light that make it work on the agent. Sometime lanes are empty of vehicles at the intersection of roads while the other lanes are filled by them according to the working hours and direction. For example: In the morning, the lane which is heading to the work that is standing on the traffic light is too long line, but another lane is empty. And the same thing In the evening At the end of work .If we are able to make the traffic light interacts with congestion by opening congested lanes for a longer time .This way will achieve a great achievement in this

field and save time, effort, and money .To alleviate traffic congestion in urban areas, the concept of Intelligent Transportation Systems (ITS). ITS is a highly promising system for providing key solutions to current road congestion problems [6]. The use of traditional methods and not to improve the performance of urban traffic signal control system to the road conditions are effective modeling and control because of the vagaries of time, non-linear, fuzzy and non-determinism in the system. Rapidly developing of artificial intelligence (AI) field can access to Adaptive this mean urban area traffic signals coordinated control system, it is supposed to respond to traffic demand and online optimum timing plans in time, and then implement real-time control. Recently, major research on urban traffic focuses on artificial intelligence techniques, such as fuzzy control, genetic algorithm and neural network [2][7]. Fuzzy logic controller for an isolated intersection, obtained intersection fuzzy control parameters from neural networks, and improved fuzzy control result [3][4][18]. Traffic signal control intersection signal (adjacent intersection) with fuzzy algorithm, and updates fuzzy control rules with genetic algorithm. The length of current green phase is extended or terminated depending to Arrival is number of vehicle approaching the green phase and Queue is that corresponds to the number of queuing vehicles in red or green phases. A GFS is basically a fuzzy system augmented by a learning process based on evolutionary computation, which includes genetic algorithms, genetic programming, and evolutionary strategies, among other evolutionary algorithms (EAs) [1]. The multi agent systems evaluated two things delay of vehicles and stoppage time of vehicles. Where, reduce total traffic delay by adjusting parameters such as cycle, splits, phase sequences and offsets according to changes of the traffic volume.

II. FUZZY LOGIC SYSTEMS

Fuzzy logic is easy, very suitable for non-linear processes and ability to take decision even with incomplete information, such as traffic police man can lead traffic quickly and effectively. Fuzzy logic allows the manipulation of linguistic data (Large, Medium and Small) and inaccurate, as a useful tool in the design of signal timing. In this paper, function of Membership is analysis variable of fuzzy for two inputs and one output as it is shown: 1) Variable of Input AVi is the numbers of the vehicles when they arrive at the crossroad (Arrival).2) Variable of Input QGi is the number of the queue of vehicles (Queue). 3) Variable of Output is the Extension of Time in the current green phase, it is symbolize by (ΔT) [9]. The graphical representation of the linguistic variables is presented as it is shown in Figure 3. we can see the Degree of membership of fuzzy variables on y-axis and the universe of discourse it is also called the reference super set on x-axis (Time second) . Fuzzy Variable of Output which is existed in x-axis it is called the universe of discourse is the length of time to extend it (seconds). linguistic values are divided into different fuzzy subsets: 1)AVi = {VS, S, M, L, VL}.2) QGi= {VS, S, M, L, VL}.3) ΔT= {D, C, I}. VS is Very Small, S is Small, M is Medium, L is Large, VL is Very Large, D is Decrease, C is Constant, I is Increase. i refers to the sequence number of the signal current phase. the linguistic control strategy that is decided by "if-then-else" statement .The basic function of The Basic Rules of Fuzzy is representation the expert of knowledge in a form of IF-THEN a structure of the rules combine AND/OR operators. We have 25 fuzzy rules, IF the number of vehicles which are waiting in line or queuing (Q) is medium AND the number of vehicles which arrive or arrival (A) is small THEN the allocated time for the green light (T) decreases [13]. Inference Engine divides into two classes: the first class is an assignment of the Inference and the second class is mechanism of action Inference. An assignment of the Inference, it reduces time of the total delay and waiting of vehicles as well as to avoid traffic congestion and synchronization of the local traffic controller with its neighbours. The green lights will be extended and the next phase is continued with notice the density of the vehicles at any junction. The mechanism of action Inference, the fuzzy inference evaluates the stored rules in the basic rules of fuzzy and then sending it to Defuzzification. Its job is process of input functions of Membership (AVi, QGi) to convert (retranslate) values the fuzzy output (ΔT) to become real crisp values. Fuzzy logic cannot be learning, adaptation, and parallel computing, while these effects exist in neural networks. Because lack of flexibility of neural network interaction and representation of knowledge using fuzzy logic.

III. THE GENETIC ALGORITHM (GA) AND GENETIC FUZZY SYSTEMS (GFS)

Genetic algorithms (GAs) try to perform an intelligent search to find a solution from a nearly infinite number of possible solutions by creating new generations. It is obtained from Darwin's Theory which means the law of the jungle (survival of the fittest). Genetic algorithms(GAs) are able to explore a large space , find better offspring (children) in complex search spaces during successive generations by a new generation and it has to be better than the previous generation. Genetic algorithms (GAs) processes for selecting solutions consist of three operators and they are: reproduction, crossover and mutation where all of them are existed in genetics.

The advantage of producing process of a new generation: 1) the evaluation which is repeated in order to reach to a better generation. 2) It searches for a solution from a broad range of possible solutions for giving expected results instead of searching in a narrow domain. The Genetic algorithm(GAs) describes attempts in order to arrive to perfect search in vacant spaces in parked vehicles such as medium speed, maximum speed, vehicle location, desired speed, current acceleration ,The proper angle of the vehicle and wheel, unique number for selecting the vehicle identification ,traffic standstill, resume motion, and return to standstill again, and so on. The genetic learning process aims for designing and optimising the knowledge base (KB). The knowledge base (KB) consists of two components and they are: 1) a database (DB) which consists of the linguistic rules and the functions of the membership. 2) Rule base (RB) that means multiple rules simultaneously for the same input. The use of The Genetic algorithm for automatic learning of Basic Rules of Fuzzy systems (BRFS) can optimize search problem and the design process can be analysed as a search problem in the space of rule sets by coding of the chromosome model.

Shortcomings BRFS are not able to learn, but it needs knowledge base (KB), which is derived from expert knowledge. BRFS are analysis process as a search problem in the space of rule sets, through coding of the model in a chromosome and the most extended in GFS .it is used the genetic Basic Rules of Fuzzy systems (GBRFS). The genetic fuzzy systems (GFS) [12] are used for designing fuzzy systems. They provide them the learning, adaptation capabilities and sharing in the genetic learning process [1][11]. GBRFS Support technological development more than BRFS for achieving the automatic generation, modification or part of the knowledge base(KB) . The Genetic algorithm (GA) is executed to obtain the best possible solution and steps of algorithm are initialize population, evaluate population, chromosomes selection and chromosomes recombination. This is done by arranging the elements of the chromosome in increasing values which is given by the Fitness Function (σi). It can measure throughout the total driving and waiting times. The genetic process is the result of the interaction among the evaluation, selection and creation of solutions, which represents the contents of the knowledge base (KB) of a BRFS. As it is shown in figures 1.

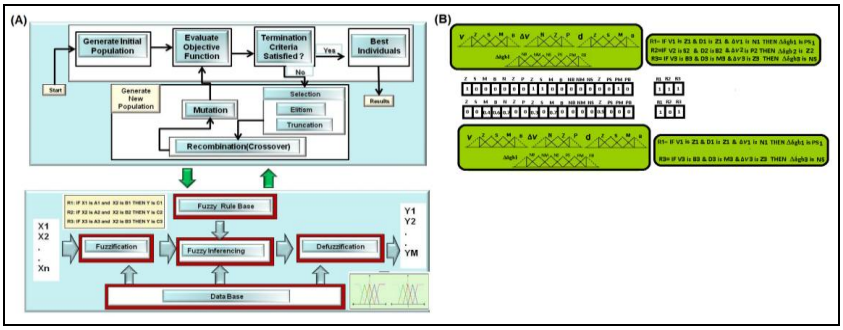

Figure 1: (A), General Scheme of Evolutionary process in genetic with Fuzzy (GFS). (B), Example of genetic with Fuzzy (GFS) and rule selection.

IV. FUZZY NEURAL NETWORK

Artificial neural network (ANN)[5] By integrating the two approaches ANN with Fuzzy call Neural fuzzy network (FNN), it is possible to overcome the deficiencies associated with using a single approach (ANN or Fuzzy) .FNN using to solve the real time arterial coordinated control problem on road. Researchers have long felt that the neurons are responsible for the human capacity to learn. Aiming to develop new architectures to improve learning and skills upgrading of knowledge representation. Incorporating FL into the NN allows a cognitive uncertainty in a similar way to treat humans. Having the potential of parallel computation with high flexibility become machine more intelligent and effectively with the increasing complexity of congestion road. Neural fuzzy network (FNN) could be as a rule-like NN. A network that topologically is structured as a rule-based system with "IF-THEN" clauses, vagueness of defining complexity classes that can be processed and solved using concepts of fuzzy logic. Learning systems use artificial neural network (ANN) calculate decisions by learning from successfully solved optimal [15]. Learning system such as ANN, knowledge is represented in the form of weighted connections, making decision tracing or extraction difficult. Expert system is knowledge-based systems extensively explored as approaches for decision making where rely on a knowledge base developed by human reasoning for decision making. Acceptability of the

solution and correctness of the reasoning process by evaluating the trace generated by the inference engine or analysing the rule base (use "IF THEN" rules). The main features of FNN [8].

- the accurate learning
- adaptive capabilities of the neural networks
- Generalization and fast-learning capabilities of fuzzy logic systems.

The fuzzy neural network [3] that is used in our work is a five-layer neural network as shown in Figure 2 designed according to the working process of fuzzy controller systems. We explain how a neural network can be used to determine membership functions. A neural network is a technique that seeks to build an intelligent program to implement intelligence .The relation and functions of the nodes in the network are as follows.

4.1. The first layer

Input layer consists of two nodes, the input linguistic variables QGi and AVI. The first layer can be written as

$$AVi=N^1_1 \text{ , } QGi=N^1_2 \qquad (1).$$

4.2. The Second layer

Membership function layer consists of ten nodes. Each node in this layer represents the membership function of a linguistic value associated with an input where linguistic variable is {VS, S, M, L, VL}.The output of each node in the interval [0, 1] Gaussian function [4] is used to divide the output signal of each node is:

$$N^{(2)}_{JK}=exp^{-\left(\frac{Njk^{(1)}-aik}{bjk^2}\right)^2} \qquad (2).$$

Where α_{jk} and b_{jk} are parameters that control the centre and the width of the Triangle , respectively. Parameters will be adjusted in back propagation. $w^i jk$ represents the weight associated with the path connecting the jth element of the ^{i}th layer to the kth element of the (i + 1)th layer. Show appendix I.

4.3. The Third Layer

Fuzzy rules are the relationship between ex ante and ex post , and each action is a set of fuzzy rules organized and composed Fuzzy 25 of the rules. Node of the third layer of computing fire combiner rule is interpreted in accordance with the rules as proposed minimum operator Zadeh [5]. Result of this layer can be represents as

$$N^3_p = Min\ (N_{jk}) \qquad (3).$$

Where p=1...25. p is the number of rules; we have 25 rules in our work.

4.4. The forth layer

The relationship between third and fourth layers is fully connected, so that all possible fuzzy rules, the embedded network structure. The weight α_p ($1 \le p \le 25$) of an input link in the layer represents the certainty factor of a fuzzy rules. These weights are adjusted fuzzy rules to learn the knowledge. We choose the max-operator suggested by Zadeh [5] the results of this layer.

$$N^4_j = Max(\alpha_p.N_p) \text{ ,where } j=1,2,3. \qquad (4) .$$

4.5. The fifth layer

This layer is called defuzzification [6]. Node in this layer is the output linguistic variables and performs defuzzification . We chose the final product of the correlation and fuzzy defuzzification focus position and function of the output node is defined as follows:

$$N=\sum_{j=1}^{3} N_j^3 a_j b_j / \sum_{j=1}^{3} N_j^3 a_j \qquad (5).$$

Where aj and bj are the area and centroid of the membership function of the output linguistic value respectively.

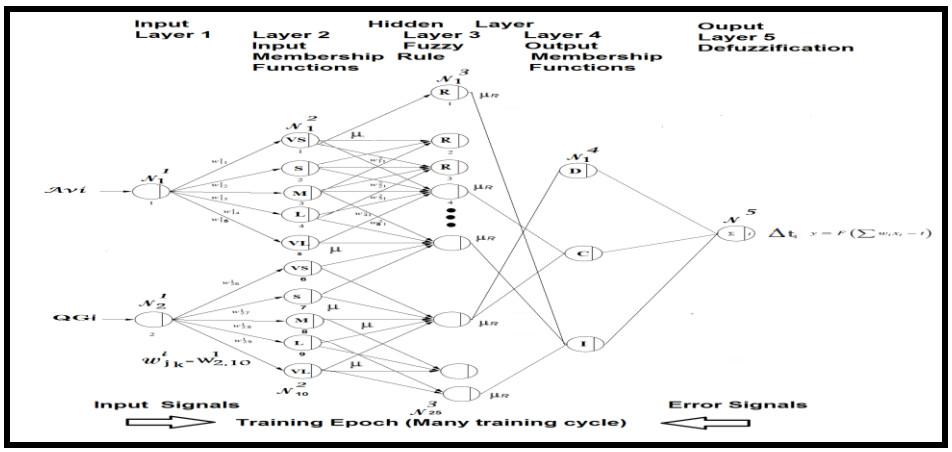

Figure 2: Model of Fuzzy Neural Network.

V. GENETIC WITH FNN

The most popular approaches to machine learning are artificial neural networks and genetic algorithms. Determine the optimal learning using GA with FNN. We see more problems with the back-propagation algorithm with GA are connected instead of back propagation as a way to find a good set. Back−propagation on a given training example consists of two parts 1) the forward propagation of activation and the calculation of errors at the output units 2) the backward error propagation and adjusting of the weights, the second part requires more computation. Moreover GA takes less than half the computation of back−propagation iteration. Only alleles representing different layers and having a binary value of one (1) are connected to one another. Shows a possible mapping of a chromosome to antecedent– implication relations; shown in figures 3.

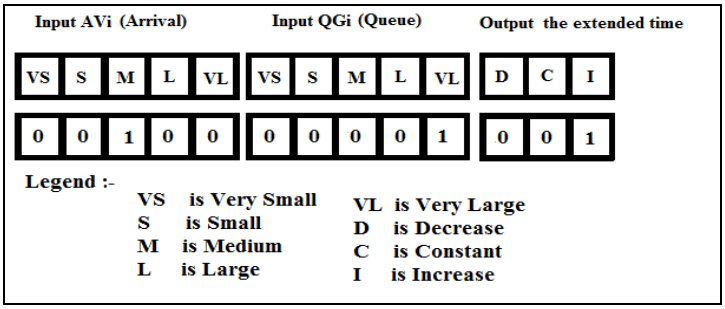

Figure 3: Model of Genetic Fuzzy Neural in hidden layer

VI. FORMATION OF FNN NETWORK WITH GENETIC ALGORITHM

The Traffic Management system is designed scientifically for provide an optimum throughput of vehicles through an intersection. Traffic signal control strategy is provided using genetic algorithms to provide near optimal traffic performance for intersections. To reduce classification error, it is necessary to improve the compression system with feedback from the classifier [10]. We use the genetic algorithm to choose the best filter coefficients in ADPCM. The fitness function which measures the ADPCM filter performance is the pre- and post-ADPCM classification error. ADPCM predictors are tested to minimize the least mean square (LMS) is a very simple algorithm, and a good choice to update the predictor. Mean square based adaptive algorithm that aims to minimize the squared error in prediction [8]. Genetic algorithm is used to minimize the least mean square (LMS) between the actual data and the predicted data is.

$E(n) = \Delta t(n) - \Delta \hat{T}(n)$. (6).

Where $\Delta t(n)$ The signal to be transmitted or stored. $\Delta \hat{T}(n)$ the output of the adaptive predictor. $\hat{e}(n)$ The quantized error to be transmitted or stored. Construct the training algorithm

1. The time of traffic light and converted to the system code Gray.
2. Define squared error as fitness function of GA and FNN weights as its variables.
3. Produce an initial population of individuals.
4. Evaluate the fitness of all individuals' Select fitter individuals for reproduction Recombine between
5. individuals Mutate individuals Evaluate the fitness of the modified individuals Generate a new population. Check, if a termination criterion is satisfied. Get the solution (the current generation). Termination criterion is set to stop the working of algorithm. Usually, it is set to a fix number of generation. Maturity level can also be used as termination criteria

VII. SIMULATION AND RESULTS

7.1. The Intersection

Intersection consists of four ways, two-lane junction hence eight lanes and it has an entry node, an exit node for each lane and one intersection node (junction). An isolated signalized intersection with four-legs in each leg and Traffic signal is controlled by four phases. Decisions were made every 10 seconds to decide. Minimum of cycle is about 20 seconds and maximum of cycle is about 820 seconds so Max Phase 205 Seconds.

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7.2. Simulation

The Criterion of optimization is the decrement length of queues and the average of waiting time vehicles in intersection. The minimum green time is preset as 5 seconds in order to let the vehicles cross the intersection safely. The maximum of the extension of green time is 40 seconds. The parameters of this GA are set as: Population size=200, crossover probability=0.5, mutation probability=0.01[14].

7.3. Results

For testing our traffic control system, we compare results fuzzy systems (FS) and genetic algorithms (GA) control with fixed time control system (static control) it is shown figure 9. Results show that it could shorten the queue, and reduce total traffic delay. We did this experiment on 1000 vehicles in intersection it is shown in table I and shown in figures 4, 5.

TABLE I: Waiting Time Comparison for 1000 Vehicles

Control Method	Average Waiting Time(second)
Fixed Time Control	**217 s**
FNN control with BP	**65 s**
FNN control with GA	**33 s**

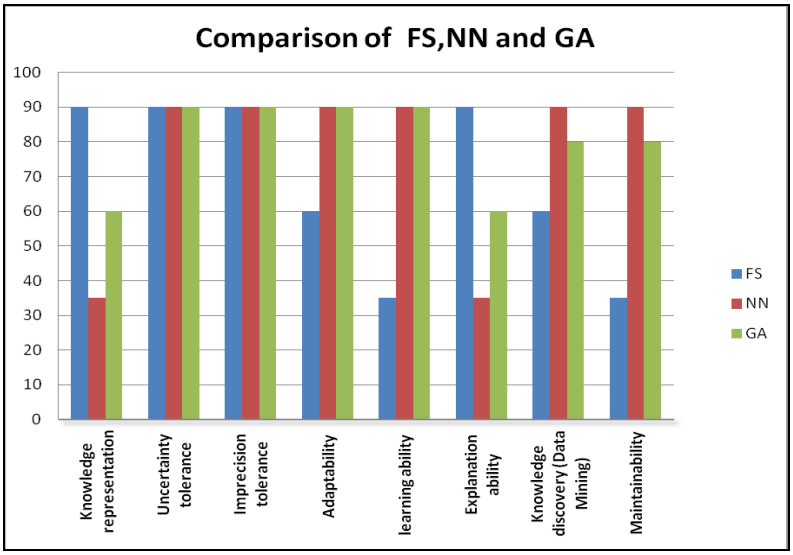

Figure 4: Comparison of Fuzzy Systems (FS), Neural Networks (NN) and Genetic Algorithms (GA).

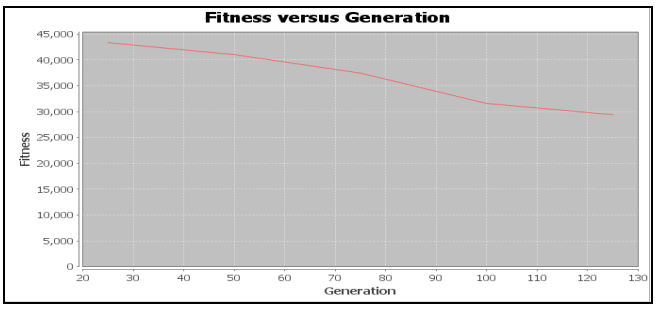

Figure 5: Fitness Generation

VIII. CONCLUSION

In this paper multi agent system demonstrates clearly superior performance for the 24-h .we applies the Fuzzy Neural Network (FNN) model to traffic signal controller. The most popular approaches to machine learning are artificial neural networks and genetic algorithms. Machine learning mechanisms form the basis for adaptive systems. So machine learning involves adaptive mechanisms that enable computers to learn from experience, learn by example and learn by analogy. Artificial neural fuzzy network models can be powerful predictors of the timing of traffic on intersection. Genetic algorithms are able to evolve predictive equations, either randomly synthesized or in the framework of existing process equations. We use genetic algorithm for learning process and choose the best filter coefficients in ADPCM By the learning of the neural network, we can tune the fuzzy model and optimize system's parameters. The research results have proved feasibility and validity of the proposed FNN algorithm.

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