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SUMMARY OF DOCTORAL THESIS

**Intuitionistic Fuzzy Logic Applied to Real-Time Traffic
Modelling and Optimization**

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CHAPTER ONE: INTRODUCTION

Congestion and the huge increase in the number of vehicles have become a major worry in many countries, and it sometimes became difficult to control of the ambulance drivers, police, and the decision-maker. There is no justification for some drivers to push their vehicles during peak time of days that affects negatively on the flow of traffic, such as the hunt for a parking place or taking inappropriate ways. Solving traffic congestion always be traditional solution in the promotion of infrastructure, such as building tunnels and bridges. This solution faced many obstacles in some lands and it cannot be applied inside them for the following reasons: Firstly, it necessitates a lot of money that it is costly to their budget. Secondly, the usable space is very limited and dangerous in countries in which earthquakes occur. Thirdly, roads are affected from the terrain such as the existence of the road above the rivers and the mountains. The traditional methods for traffic management, surveillance and control are not adequately sufficient in terms of the performance, the cost and the effort such as air pollution, excess fuel consumption and business delays. Conventional traffic light control through static control that means the traffic changes in fixed cycle times, which are constant cyclical and it is not optimal. The conventional traffic controller is unable to solve the congestion at the intersection because there are empty lanes of vehicles at the intersection of roads while the other lanes are filled or occupied with them according to the rush hours and direction. Traffic has many variables like the season, weather and unpredictable situations such as accidents, special events or constructional activities. In order to overcome the congestion management violations on the roads, they hold to be an automatic registration of vehicles in public places, roads and traffic lights when exceeding the speed limits, because A vehicle plate is real important for vehicles like the DNA of humans (DNA). It is a way to differentiate between your vehicle and the one thousand thousand of similar vehicles in all over the world. Thus, we need to exploit the existing infrastructure in order to surmount the obstacles which are mentioned above to optimize the traffic management and reduce delay. Overcoming traffic obstacles during interaction with the surrounding environment with use The Intelligent Transport System (ITS). Intelligent Transport System (ITS) integrates advanced electronics, communications, information technology and wireless sensors to realize more about the environment, in order to attain and ensure safety and comfort for drivers along the roads. Humans are unable to gather data that will serve to find lanes and searching for vacant places and detecting the rapid detection of the plate of the vehicle. Wireless sensor network is used to recognize the vehicle incoming and outgoing in lanes, vehicle plate, find vacant spaces in parked vehicles the shortest possible time. To assist drivers in finding the ways that do not contain any obstacles we use fuzzy logic and Neural Networks with Genetic algorithm.

CONTRIBUTIONS

Human cognition is an analytic thinking of complex information in order to obtain solutions and this data is vague concepts, imprecise and uncertain. In this thesis, we used Polygamy Technology is similar to the human in the analysis of information missing or ambiguous in the rapid detection of the surrounding environment in real time. Polygamy Technology able to incorporate human knowledge and experiences to react quickly in unknown environments, adapt to conditions and ability of taking decisions with incomplete information, complex equations and non-linear processes. In our study exploit of infrastructure and take advantage of communication techniques wired, wireless, ultrasonic sensors and GPS to communicate with other vehicles or infrastructure on beside roads and aid in fast disseminating information in real time. In our thesis, overcomes the drawbacks Dynamic obstacles require knowing many of things as follows: 1) Changing of behavior for objects such as the maximum speed, acceleration. 2) A wide variation of the size, shape or texture such as change of a vehicle plate or roads. 3) An outdoor environment is external change such as weather conditions, varying lighting, ubiquitous shadows, dirt balls, dirt, insects, realization of the colors, luminance and brightness intensity. We used the Intuitionistic Fuzzy Set for solving problems during using the inference and extract Cut-Node (CN) in order to identify obstacles and avoid them and to extract the best path and recognize the vehicle plate. Three models have been suggested to extract Cut-Node (CN) with using algorithm Intuitionistic Fuzzy Neural Network with Genetic Algorithm (IFNN-GA), instead of the Back Propagation Network (BPN), as follows: 1) The Intuitionistic Fuzzy Set (IFS) is a part of Zadeh's fuzzy set, developed by Atanassov. 2) The Intuitionistic Fuzzy Set DataBase (IFDB) is representing imprecise data. 3) Interval-Valued Intuitionistic Fuzzy Set (IVIFS).

Goals

The goal of the dissertation is determining the reason of the delay which is face drivers and decision-makers and overcome them, Forms of delay are as follows:

[First] Mandatory delay which has faced the drivers and decision-makers by the decisions of others, as follows: 1) Places of delays along the roads are mainly at the traffic lights specifically at intersections. 2) Unpredictable delay which is faced while driving, such as changes in illumination and shadows, weather conditions, accidents, congestion, complex shapes of the road, special events and maintenance of roads (constructional activities).

[Secondly] Non Mandatory delay, that the drivers and decision-makers by their decisions. Choose roads who depends on the task as an ambulance that choose the shortest way to save lives or taxi that choose the comfort roads and safety.

[Thirdly] The delay relies on the human capacity (understand, conservation and efficiency): 1) Policeman's ability to analyze: a) The panel vehicles or determine the type of vehicle and color. b) Ability on giving the priority for necessary vehicles, and search for stolen vehicles. 2) Drive's ability to search about the parked for finding the vacant space.

The purpose of knowing the reasons for the delay and the prospect knowing future to overcome them through the following: 1) Discover ways that do not contain any obstacles, to maximize safety, minimize delays and environment pollution, reduce the travel time, provide alternate routes for travelers, save fuel, prevent stealing vehicles, help people and save them. 2) Extend time green color in the lane which depends on a density of vehicles at intersections. 3) Reach the target with commitment in speed of assessed road. 4) Find vacant spaces in parked vehicles without losing time and the realization of vacant spaces that can be is, occupied, reserved for handicapped and VIP. 5) Vehicle surveillance in order to analyze and understanding the vehicle plate.

CHAPTER TWO: LITERATURE REVIEW

Many researchers strive to solve the traffic congestion problem and try to overcome the Inefficiency of conventional traffic surveillance systems. The techniques of these researches can be classified as follows: intrusive and non-intrusive (above ground) sensors. Transportation management system (TMS) is adapted and improvement of the performance of the controller to help the drivers and decision-maker. Mating the technology (FL, GA, and NN) based on TMS under the unpredictable conditions to reduce the loss of the incurred congestion.

Management Transportation Smart

Lin, uses the genetic algorithm the traffic network to reach the perfection. Jose proposes to improve the traffic control system in congested areas within cities and the genetic algorithm has applied to implement the mutations and the reproduction.

Fuzzy logic was applied in 1965 by Lotfi A. Zadeh. Basically, fuzzy logic is a multi-valued logic that allows for intermediate values to be defined among conventional evaluations like true/false, yes/no, high/low,... etc. Notions like “rather tall” or “very fast” can be formulated mathematically and processed by computers, in order to apply a more human-like way of thinking in the programming of computers. They are able to receive inputs, process them and then produce outputs during inference that are structured in a neural network.

Pappis and Mamdani, present a wide solution for fuzzy logic applications in different regions of the traffic problems and the transportation because they mimic human intelligence and it has been obtained a list of conclusions which are summarized as following: (1) Most applications of FL for the traffic problems are still in the development phase and applied in a simulated environment. (2) The applications of Intuitionistic Fuzzy Set (IFS) for the traffic problems produce satisfactory results in the real-life or simulated environment. (3) The ability of Intuitionistic Fuzzy Set (IFS) to understand vagueness, uncertainty, ambiguity and decision in the traffic such as, route-choice and vehicle-following behavior. (4) The ability of Intuitionistic Fuzzy Set (IFS) to combine data, it is able to handle missing and conflicting data and increases the accuracy of the estimates.

The Traffic Control System

The traffic control system consists of two main parts:

- 1) The wireless sensor network which constitutes the new traffic infrastructure. The GPS signal cannot be accurate enough for parking, For this reason, the development of intelligent systems on roads and parking vehicles in real time, through enhancing the capacity of roads and traffic flow, which are based on wireless networking and infrastructure, that includes the following: 1) Roadside Units (RSUs). 2) On-board Units (OBUs) such as: a) Cellular Networks. b) Wireless Access Points (APs). c) GPS satellites for position information and the vehicle speed information.
- 2) The intelligent traffic controller, which is represented by the intelligent control algorithms at roads or single-intersections and multiple-intersections.

Adapting Technology Polygamy

In many cases, each part of polygamy (FL, GA, NN) when working separate on the other does not have sufficient expertise, resources and information to solve a problem. On the other hand, maybe one of polygamy might have the expertise to solve one part of the problem. Polygamy mechanisms can be classified into three main categories: cooperative, concurrent and integrated. A good understanding of the cooperation mechanisms is necessary before the concept of cooperation. The concept of cooperation can be applied in polygamy the definition is as follows: when two or more of polygamy work together in a common environment to more effectively reach. Polygamy techniques have attracted the growing interest of researchers in various scientific and engineering areas due to the growing need of adaptive intelligent systems to solve the real world problems. In the simplest way, a cooperative model can be considered as a preprocessor wherein artificial neural network (ANN) learning mechanism determines the fuzzy inference system (FIS) membership functions or fuzzy rules of the training data. Fuzzy Associative Memories (FAM) by Kosko, fuzzy rule extraction using self organizing maps by Pedrycz et al. through the systems capable of learning of fuzzy set parameters by Nomura et. During the learning process, they may be developed differently, so that identical linguistic terms are represented by different fuzzy sets. The proposed approach is applicable to type fuzzy inference Methods is Mamdani, Larsen, Tsukamoto and TSK Method. Using a similar approach, Miyoshi et al, adapted fuzzy T-norm and Tconorm operators while Yager et al, adapted the Defuzzification operator using a supervised learning algorithm. Integrated polygamy technology model through the share with data structures and knowledge representations where neural network learning algorithms are used to determine the parameters of fuzzy inference systems. A fuzzy inference system can utilize human expertise by storing its essential components in rule base and database, and perform fuzzy reasoning to infer the overall output value.

CHAPTER THREE: EQUIPMENT OF ARTERY

Congestion and the huge increase in the number of vehicles have become a major worry in many countries, and it sometimes became difficult to control of the ambulance drivers, police, and the decision-maker. There is no justification for some drivers to push their vehicles during peak time of days that affects negatively on the flow of traffic, such as the hunt for a parking place or taking inappropriate ways. City artery consists of adjacent sidewalks, turning lanes, crossing, pedestrian, bicycle and vehicle. Traffic control devices monitor the following: pavement markings, pedestrian signal, yield signs, traffic light, intersection, roundabouts, and uncontrolled intersections. They help to organize traffic in providing time for each movement to be accommodated on the street and decrease the possibility of conflict by using detection systems (such as loop detection, video camera, and microwave) must be sensitive toward bicycles. The conventional traffic controller has cycle times fixed, which are non optimal. A conventional traffic controller is unable to resolve the congestion in the intersection because there are empty lanes of vehicles at the intersection of roads while the other lanes are filled, depend on the rush hours and concentrating. In this thesis, Traffic control can be capable to overcome these obstacles and interaction with the surrounding environment. Traffic control methods include fixed-time control, area static control and area dynamic control.

Avoidance of Collision at Intersection

The road management in an intersection is hard challenge and complex to make the traffic at their best in their ability to adapt to environmental and exploited real time. Intersection is the number of lanes and each

lane equipped with sensors (radar, laser scanner and cameras) and cells. To Stop vehicles at the intersection at traffic light is the hardest challenge and complex to avoid the collision in Less time and without delay. The intersections consist of many phases, communications, and Islands. Islands at road can also help to identify the direction of the vehicle; they separate conflicting movements and refuge for pedestrian. Each link (lane) is divided into a number of cells and has a unique ID number. A size of the road-cell is 16 pixels and each vehicle occupies two cells (32 pixels), in this thesis Vehicle length medium-sized four meters, small vehicle two meters and Large Vehicle six meters (bus) where the vehicle can occupy the road-cell or not that means it will be empty. There are reasons to use Cellular Automata Algorithm (CAA) as follows: 1) To know what is happening on the roads such as traffic standstill, resume traffic, and so on. 2) To identify a vehicle's basic attributes include medium speed, upper limit velocity, vehicle position, desired speed and current acceleration. 3) To give Fuzzy value, when fuzzy equal one that implies a movement of vehicles along the roads at their best cases (without any delay), and when fuzzy equal zero that means any vehicle has not passed through this the road. Cycle length depends on real-time that can adapt or adjust according to traffic conditions or an emergency (exigency). Phase is a set of lanes in traffic and its task to pull and extract the vehicle from the intersection, by drawing the traffic flow of the green light.

Intersection Configurations

Intersections leg or multi-leg, it has many lanes, such as three, five or six legs at every the intersection but most intersections have three or four legs. Each cycle (all phases) contains of three approaches, they are: 1) Fixed-Time control (FX), it all lengths of phases (one cycle) is equal to each other. 2) Area Static control, it all lengths of phases (one cycle) predetermined, depend on statistical data in last year's. 3) Real-time control (RT) or Dynamic Approach (the same moment). An advantage of Dynamic Approach is the adaptation in the traffic situations and flow and thus will be solved many of the road problems, exploitation of real time and the modification.

Obstacles Dynamic and Static

Dynamic obstacles are the movement of targets (objects) such as automobile, vehicle, pedestrians, domestic animals, etc. Detection of obstacles is not adequate for drivers they must be capable to support safe driving and overcome the drawbacks. Overcome the drawbacks requires knowing in: 1) changing of behavior such as the maximum speed, acceleration. 2) A wide variation of the size such as change of a vehicle plate shape or texture. 3) An outdoor environment is external change for vehicles such as weather conditions, varying lighting, ubiquitous shadows, dirt balls, dirt, insects, realization of the colors, luminance and brightness intensity. Traffic surveillance by processing images and video via camera in order to a better understanding of the surrounding environment as collecting more data and detection road as off-road (not be well-paved, and rough surface).

Intelligent Parking System

The speedy maturation and development in smart vehicle industry led us to search for the management of roads and parking vehicles in everywhere in order to control of the ambulance drivers, police, and the decision-maker through clever methods. We need to environment more than smart like Intelligent Vehicles (IV) with the Intelligent Parking System (IPS) because the difficulty of finding on vacant spaces(spots) to be suitable for drivers efficient, especially at the weekend or holidays, close to their work and low fees which leads to delay, congestion and increase air pollution. Exploitation of communications services wired and wireless technologies, Intelligent Parking System (IPS) and Intelligent Vehicles (IV) for helping drivers to find vacant places in parks in the shortest possible time without losing time, save fuel, prevent of stealing vehicles, provide safety, pay and reach for them by means of communication such as the internet.

CHAPTER FOUR: FUZZY LOGIC

We talk about an intelligent traffic control system using Fuzzy Logic technology, which possesses the ability to mimic the intelligence of human that means it is also thinking like humans. We use fuzzy logic because it is capable to incorporate human knowledge and experience to respond quickly in unknown environments, adapt conditions and an ability to involve decisions with incomplete information, complex equations and

non-linear processes. It allows the manipulation of linguistic data (Large, Medium, and Small) and inaccurate, as a useful tool in the design of the intelligent traffic control system.

The Crisp Set and Fuzzy Set

The crisp set is Functions outcome which is defined as universal set X to $\{1, 0\}$. We can represent the element x that belongs to a set A or not, and defines μ_A , as follows:

$\mu_A(x) = 1$ if and only if $x \in A$.

$\mu_A(x) = 0$ if and only if $x \notin A$.

Fuzzy Logic is Included matter of Degree of membership and a deeper concept of the classic (crisp) true and false, or black-and-white. A Fuzzy Set is a set which consists of elements such that there are existing elements that is no Boolean (not 0 or 1), elements are called the Functions of the membership, but these Functions of the membership lies in the interval $[0, 1]$. A Fuzzy Set is shown as a set of ordered pairs, as follows: $F = \{(x, \mu_A(x)) \mid x \in X\}$. Where $\mu_A(x)$ indicates the membership grade of the element x in the fuzzy set, and an element, x indicates to one of the elements in Functions of the membership.

The Fuzzifying Function, Support and α -Cut

The Fuzzifying Function

The Fuzzifying function of crisp variable (\mathbb{R}) has two types, and they are: 1) Type one which is defined on a crisp set (domain, X) to fuzzy set (range, Y). $\mathbb{R}:X \rightarrow f$. 2) Type two which is defined on a crisp set (domain, X) to Fuzzy Power Set $\tilde{p}(y)$. $\mathbb{R}:X \rightarrow \tilde{p}(y)$.

Support and α -Cut

Support of A is that all elements have a greater membership than zero, as follows:

Support (A) = $\{x \in X \mid \mu_A(x) > 0\}$.

α -Cut set is that all elements have a greater membership than or equal α , as follows:

$A_\alpha = \{x \in X \mid \mu_A(x) \geq \alpha\}$.

Fuzzy Number

It achieved through a number of conditions, as follows: 1) Normalized: If there exists an element in fuzzy set that its value equals one, so the fuzzy sets are called normalized and otherwise non-normalized. 2) Cardinality: In order to get the magnitude of fuzzy sets, there are ways of measuring the cardinality (Scalar and Relative) of fuzzy sets, and they are as follows: a) Derive magnitude by Degree of membership this is called "Scalar Cardinality" as in the following equation: $|A| = \sum_{x \in X} \mu_A(x)$. B) Comparing the magnitude of fuzzy set (A) with universal set (X) that is called "Relative Cardinality" as in the following equation: $\|A\| = \frac{|A|}{|X|}$. Where $|X|$, is the number of elements of X .

Standard Fuzzy Set Operations

The most widely used operations are called standard fuzzy set operations. We used the six operations: the fuzzy Union, fuzzy Intersection, fuzzy Complement or the fuzzy negation of the specified membership function, fuzzy Exclusive-OR, fuzzy Error and fuzzy Independence. A fuzzy set operation symbol as follows (OR, maximum criterion), (AND, minimum criterion), (NOT, negation criterion), (+), (Δ) and (-) operation in Boolean algebra, respectively.

T-Norms and T-Conorms

There are two types of operators in fuzzy sets: T-Norms (Triangular-Norm, \cap) and T-Conorms (triangular-Conorm or S-Norm, \cup).

Extended Operations

The Opposite of a Fuzzy Number ($-\tilde{M}$). $-\tilde{M} = \{(x, \mu_{-\tilde{M}}(x)) \mid x \in X\}$, where $\mu_{-\tilde{M}}(x) = \mu_{\tilde{M}}(-x)$.

The Inverse of a Fuzzy Number (\tilde{M}^{-1}). $\tilde{M}^{-1} = \{(x, \mu_{\tilde{M}^{-1}}(x)) \mid x \in X\}$, where $\mu_{\tilde{M}^{-1}}(x) = \mu_{\tilde{M}}\left(\frac{1}{x}\right)$.

The Scalar Multiplication of a Fuzzy Number ($\lambda\tilde{M}$). $\lambda\tilde{M} = \{(x, \mu_{\lambda\tilde{M}}(x)) \mid x \in X\}$, where $\mu_{\lambda\tilde{M}}(x) = \mu_{\tilde{M}}(\lambda x)$.

Fuzzy Control

Requires the design of a Fuzzy Control system the following steps: 1) Choosing the fuzzy controller inputs and outputs. 2) Choosing the pre-processing that is needed for the controller inputs and possibly post-processing that is needed for the outputs. 3) Designing each of the four components of the fuzzy controller, it is Rule-Base, the Inference Mechanism, The Fuzzification Interface and The Defuzzification.

Linguistic Variable

Linguistic Variable contains a number of variables, we have been using quintet parameter, as follows: Linguistic variable = (x, T(x), U, G, M), where define the symbols as follows:

- x: name of variable such as luminance, Bumps, Type of road, Traffic signals, Housing Type, Streets subset and obstacles.
- T(x): set of linguistic terms such as luminance (Area A, Area B, ... etc.), it contain of several linguistic values (VS, S, M, L, VL).
- U: set of universe of discourse which defines the characteristics of the variable such as age, seconds, and hour.
- G: syntactic grammar which produces terms in T(x) Such as G (luminance) = $T^i = \text{Area } A^{T1}, \text{Area } B^{T2}, \dots$ Etc.
- M: semantic rules which map terms in T(x) to fuzzy sets in U, and Fuzzy Logic values on each linguistic term. The rule is interpreted as an “implication” and consists of the “antecedent (if part)” and “consequent (then part). We used the two types of “reasoning”, as follows: 1) Modus Ponens is used in the forward inference. 2) Modus Tollens is in the backward one.

Rule: {if (u is A) and (v is B) then w is C}.

The Antecedent (if part)

Input $\alpha = \langle (u \text{ is } A) \text{ and } (v \text{ is } B) \rangle$ possible to be Singleton or Fuzzy Input

The Consequent (then part)

Output $w = \langle (C, \text{consequence}) \rangle$ possible to be Fuzzy Set, Fuzzy Set with a Monotonic Function and Crisp Function.

The Basic Rules of Fuzzy

The Rule-Based expert system has three components: the knowledge base, the database and the inference engine. The knowledge base represented as a set of rules an important issue in the inference and useful for problem solving. The database includes a set of facts. The inference engine links the rules given in the knowledge base with the facts provided in the database.

Fuzzification

The Fuzzification transforms the input data (real crisp values) into fuzzy values and compared to the rules in the Rule-Base and we used some of type Functions of the membership, as Trapezoid, Gassian and Sharp peak.

Fuzzy Inference System (Expert System)

Fuzzy Inference System (FIS), is a conclusion from the data and information that is needed from the Input Fuzzy and the Knowledge Base (KB) and render the findings to the Defuzzification (Output Fuzzy). The set of rules in a fuzzy expert system is known as Knowledge Base (KB). The Mechanism of action Inference evaluates the basic rules stored and then transporting it to Defuzzification.

The inference procedure is called as the “compositional rule of inference” and determined by two factors: 1) Singleton input “implication operator”. In order to make a decision we use of inference through four methods, it is: A) Mamdani implication (RC): min operator. B) Larsen implication (Rp): algebraic product operator. C) Tsukamoto. D) TSK Method. 2) Fuzzy input “composition operator”. The four operators are often used: A) Mamdani composition: max-min. B) Larsen composition: max-product. C) Tsukamoto. D) TSK Method.

The Defuzzification

Defuzzification job is re-translate fuzzy sets (conclusions) obtained from the inference process to become real crisp values that constitute the output of the FRBS. We used the Defuzzification in several different ways

and the methods are as follows: 1) The center of gravity in the area (COA). 2) Mean of maximum method (MOM). 3) Bisector of Area (BOA). 4) Smallest of max. 5) Largest of max.

Fuzzy Logic in Colors

Baldwin (T) defined fuzzy truth qualifier in the universe of discourse, as follows:

$$V = \{v \mid v \in [0,1]\}.$$

T= {true, very true, fairly true, absolutely true, false, very false, fairly false, absolutely false}.

The Transition between Regions

The relation between the two areas (A, B) symbolizes to R. Area A contains (1, 2 and 3) and area B contains (a, b, c and d). The same thing in the relation between the two areas (B, E) symbolizes to S and area E contains (α , β and Y).

- Relations $R \subseteq A \times B$ can be expressed by function F and define in the following equation: $\mu_B(y) = \text{Max} [\mu_A(x)]$, if $F^{-1}(y) \neq \emptyset$. Where define the symbols as follows: $x \in A$, $y \in B$, $Y = F(x)$ or $x = F^{-1}(y)$ then we can obtain make fuzzy set Area B from Area A for $y \in A$.
- The Functions of the membership of fuzzy set E in B are defined as the following equation: $\mu_E(y) = \text{Max} [\text{Min} (\mu_B(x), \mu_S(x, y))]$. Where define the symbols as follows: For $x \in A$, $y \in B$, and $E \subseteq B$.
- The composition $S \circ R = SR$ of two relations R and S is expressed by the relation from A to E and this composition is defined by the following equation: $\mu_{S \circ R}(x, z) = \text{Max} [\text{Min} (\mu(x, y), \mu(y, z))]$. Where define the symbols as follows: $M_{S \circ R} = MR \circ MS$, $R \subseteq A \times B$ and $S \subseteq B \times E$.

CHAPTER FIVE: FUZZY GRAPH

The Fuzzy graphs are useful to represent relationships which deal with uncertainty and it differs greatly from classical graphs through help to find the Cut Node (CN) in Connectedness concepts. We used the Fuzzy Graphs as a module for resolve our experiment as in identifying areas of congestion. The Fuzzy Graph structure consist of two vertices x and y in a graph G^* are said to be adjacent in G^* pair is called edge of $G^*\{x, y\}$ will be denoted by (xy) is called directed graph (network, connected direction), otherwise undirected graph (not connected). A Graph represents G defined as follows: 1) The form of Graph Crisp Set as follows: $G = (V, E)$, where V: Set of vertices. A vertex is also called a node or element. E: Set of edges. An edge is paired (x, y) of vertices in V. 2) The form of Graph Fuzzy Set as follows: $\check{G} = (\check{V}, \check{E})$. Where \check{V} : fuzzy set of vertices (nodes, elements). \check{E} : fuzzy set of edges between vertices.

A graph is a data structure expressing relation $R \subseteq V \times V$. $\sigma: V \rightarrow [0, 1]$, where $G: (\sigma, \mu)$ and σ is a fuzzy subset of V and μ is a symmetric fuzzy relation of the σ . A fuzzy relation μ on V is $\mu(u, v) \leq \sigma(u) \wedge \sigma(v)$ for all u, v in V. Where \wedge is minimum. μ and v are fuzzy relation on V, then $\mu \circ v(u, w) = \sup \{\mu(u, v) \wedge v(v, w) : v \in V\}$.

Fuzzy Graphs Theory

The fuzzy graph theory has numerous applications in various fields. We introduced the regular fuzzy graphs, total degree, totally regular fuzzy graphs and Regular Fuzzy Graphs on a Cycle.

Areas of Congestion

Connectedness concepts help to find the Cut Node (CN) in fuzzy graphs in order to identify obstacles and avoid them such as varieties that occur in the lighting, weather conditions, accidents, congestion and maintenance of roads. It's useful in understanding the surrounding environment, supporting safe driving, increases the flow. The conditions of achieving CutNode (CN) as in the following steps:

1. Strong fuzzy graph (SFG) if $\mu(u, v) = \sigma(u) \wedge \sigma(v)$, $\forall (u, v) \in \mu^*$. It every pair of vertices are connected in edge or multiple edges without loops (the finite number of vertices and edges).
2. Complete fuzzy graph (CFG) if $\mu(u, v) = \sigma(u) \wedge \sigma(v)$, $\forall (u, v) \in \sigma^*$. Where $\mu(u, v)$ denotes the edge between u and v. It every pair of vertices are connected in edge or multiple edges with loops.
3. Cycle if $u_i = u_n$, and ≥ 3 where $I = 1, 2, 3 \dots n$ and n is a natural number $\{n \in \mathbb{N}\}$.

4. Path (p) of length n is a sequence of nodes such that $\mu(u_{i-1}, u_i) \geq 0$
5. Weakest arc in the path, it's called its strength. In order to give the strength of connectedness between any two nodes (u, v) in all the paths, we use the following equation:

$$\mu^\infty(u, v) = \sup \{ \mu^1(u_1, v_1) \wedge \mu^2(u_2, v_2) \dots \wedge \mu^n(u, v) : n=1, 2, \dots, u_n=v_{n-1} \}$$
6. The Complete Graph able to know the number of edges, as in the following equation:

$$\text{Edges} = \frac{n*(n-1)}{2}$$

Intuitionistic Fuzzy Sets (IFS)

The Intuitionistic Fuzzy Set (IFS) developed by Atanassov, and constitutes an extension of Zadeh's fuzzy set and assigns on each element degree of membership. It is a powerful tool to deal with vagueness and use its most general and comprehensive than fuzzy set. We used the Intuitionistic Fuzzy Set because more accurate and minimize the search through inaccurate information analysis and extraction results.

Intuitionistic Fuzzy Sets (IFS) have three values and they are $\mu_A(x)$ and $V_A(x)$, where $\mu_A(x)$ is a degree of membership, that means information are understandable, $V_A(x)$ is a degree of non-membership, that mean information are not understandable, and non-membership, and $\Pi_A(x)$ is a degree of uncertainty, that means information are not understandable and contains errors. The sum of the three values has to be less than one (1), it can be expressed as follows: IFS A = $\{ \langle x, \mu_A(x), V_A(x), \Pi_A(x) \rangle : x \in X \}$.

Operations Intuitionistic Fuzzy Set (IFS)

The operations Intuitionistic Fuzzy Set (IFS) contains Conjunction and Disjunction, as follows:

- Conjunction. It has two forms and they are (&) and (\cap).
- Disjunction. It has two forms and they are (\cup) and (\cup).

Intuitionistic Fuzzy Relation

We introduce an application or case that using the Intuitionistic Fuzzy Relation, as follows: 1) Intuitionistic Fuzzy Tolerance Relation, if R is reflexive and symmetric relation. 2) Intuitionistic Fuzzy Similarity Relation (Equivalence), if R is reflexive, symmetric and transitive relation, as follows:

- Reflexive relation

$$\forall x \in A \Rightarrow \mu_R(x, x) = 1$$
- Symmetric relation

$$\forall (x, y) \in A \times A, \mu_R(x, y) = \mu \Rightarrow \mu_R(y, x) = \mu$$
- Transitive relation

$$\forall (x, y), (y, z), (x, z) \in A \times A$$

$$\mu_R(x, z) \geq \text{Max}[\text{Min}[\mu_R(x, y), \mu_R(y, z)]]$$

Strong Intuitionistic Fuzzy Graphs

Strong Intuitionistic Fuzzy Graphs, is useful to handle in understanding and awareness with uncertainty or may not be known exactly, such as the ability of vehicles to move at an acceptable time and the movement of vehicles, even under different weather conditions (sunny and rainy) and choose the best safety methods. In our thesis, sunny is minimized and rainy is maximum of more safety.

Operations on Intuitionistic Fuzzy Graphs

We used the operations on the Intuitionistic Fuzzy Graphs, as follows: The Cartesian product IFG, The Composition Of Two Strong IFG, The Union of Two Intuitionistic Fuzzy Graphs, The Join of Two Intuitionistic Fuzzy Graphs, and Intuitionistic Fuzzy Line Graphs.

Intuitionistic Fuzzy Data-Base

The Fuzzy set is used to represent imprecise data and it is called an Intuitionistic Fuzzy Database (IFDB). It is a generalization of the classical database and defined as set of relations where each relation is a set tuple.

Interval-valued Fuzzy Set

Interval-Valued Fuzzy Sets are extensions of the theory of fuzzy sets and others to attempting on coping inaccuracy. IVFS is a further degree of membership values are intervals of numbers instead of numbers. Interval-Valued Fuzzy Sets provide a more adequate description of uncertainty and are widely studied than traditional fuzzy sets. It can be, as follows:

$$A = \{x, D(x) \mid x \in X\},$$

$$D(x) = [\mu_a^-, \mu_b^+] \in [I].$$

Where define the symbols as follows:

- $D(x)$ is called an interval-valued fuzzy number.
- An interval number D is an interval $[a^-, b^+]$ with $0 \leq a^- \leq b^+ \leq 1$.
- μ_a^- , μ_b^+ are the lower and the upper extreme, respectively.

Interval-Valued Intuitionistic Fuzzy Set

Interval Values Intuitionistic Fuzzy Sets (IVIFS) are extensions of the theory of fuzzy sets and others are trying to cope inaccuracy and uncertainty differently. It can be expressed as follows:

$A = \{x, (D(x), J(x), H(x)) \mid x \in X\} \in [I]$. Where define the symbols as follows:

- $D(x)$, $J(x)$ and $H(x) : X \rightarrow [I]$ represent the degree of membership and non-membership and the hesitation part (Error), of the element $x \in X$, respectively.
- $D(x) = [\mu_a^{-1}, \mu_a^{+1}] \in [I]$. $J(x) = [\mu_a^{-2}, \mu_a^{+2}] \in [I]$.
- $0 \leq [\sup(D(x), \mu_a^{+1})] + [\sup(J(x), \mu_a^{+2})] \leq 1, \forall x \in X$.
- μ_a^{-1} and μ_a^{+1} , are the lower extreme, μ_a^{-2} and μ_a^{+2} , the upper extreme, respectively.
- So $A = ([\mu_a^{-1}, \mu_a^{+1}], [\mu_a^{-2}, \mu_a^{+2}], [\mu_a H^{-1}, \mu_a H^{+1}])$.

Intuitionistic Fuzzy Expert System

It uses types IFS with Fuzzy Expert System, consists of: 1) IFS with Fuzzy Expert System, it ordered pairs of real numbers from set $[0, 1]$, namely using Functions of the membership instead of Boolean logic. 2) IVIFS with Fuzzy Expert System, it intervals of numbers, instead of numbers and Boolean logic. It has three components: 1) The Knowledge Base (KB) set of rules in an Intuitionist Fuzzy Expert System.

2) The Database: includes a set of facts. 3) Intuitionist Fuzzy Inference system (IFIS), is a conclusion from the data and information that is needed from the Input Intuitionist Fuzzy and the Knowledge Base (KB) and render the findings to the Output Fuzzy.

Distances Measure for fuzzy sets

Distances Measure for fuzzy sets, Classical fuzzy sets which are a special case of Intuitionistic Fuzzy Sets. We used the some types, distance measure to fuzzy sets, as follows: a) The Hamming Distance or symmetrical distance. b) The Normalized Hamming Distance. c) Minkowski Distance.

Distances Measure for Intuitionistic Fuzzy Sets

Distances Measure for Intuitionistic Fuzzy Sets, when calculate the distances among the intuitionistic fuzzy sets, we took all parameters (Three) that describe intuitionistic fuzzy sets. We used the some types, distance measure to Intuitionistic Fuzzy Sets, as follows: a) The Normalized Hamming distance. b) The Normalized Euclidean distance.

Distances Measure for Interval-Valued Intuitionistic Fuzzy Sets

Distances Measure for Interval-Valued Intuitionistic Fuzzy Sets (IVIFS), we used the some type distances measure to IVIFS: The normalized Hamming distance with hesitate parts. In our study, we obtained Distances Measure for fuzzy sets from different intervals, which are less accurate, and more different than Distances Measure for Intuitionistic Fuzzy Sets. In our study, we obtained IVIFS more accurate and less different than Distances Measure for Intuitionistic Fuzzy Sets.

Interval-Valued Intuitionistic Fuzzy Weighted Arithmetic Average (IIFWAA)

IIFWAA to collect fuzzy information from the road, it is defined as follows:

$$A = ([\mu_a^{-1}(x), \mu_a^{+1}(x)], [\mu_a^{-2}(x), \mu_a^{+2}(x)], [\mu_a H^{-1}(x), \mu_a H^{+1}(x)]).$$

IIFWAA (A) =

$$\left\{ \left[1 - \prod_{i=1}^n (1 - \mu_a^{-1}(xi))^{wi} \right], \left[1 - \prod_{i=1}^n (1 - \mu_a^{+1}(xi))^{wi} \right], \left[\prod_{i=1}^n (\mu_a^{-2}(xi))^{wi} \right], \left[\prod_{i=1}^n (\mu_a^{+2}(xi))^{wi} \right] \right\}$$

Where $w = (w_1, w_2 \dots w_n)^T$ is the weight vectors of A. $w_i > 0$, $\sum_{i=1}^n w_i = 1$, and we use $w = (1/n, 1/n \dots 1/n)$.

CHAPTER SIX: POLYGAMY TECHNOLOGY WITH FL, NN AND GA

Human knowledge is an analytic thinking of complex data in order to obtain solutions and this data is vague concepts, imprecise and uncertain. In this research, compared with the human, is useful in the management of violations faced by observers on crowded highways. The integration, sharing and helping each from Fuzzy logic and Neural networks with Genetic algorithm, became able to incorporate human knowledge and experience to react quickly in unknown environments, adapt conditions and an ability to take decisions with incomplete information, complex equation and non-linear processes. Fuzzy logic and Neural networks with Genetic algorithm, which became known as Fusion or Polygamy Technology. We use Fusion or Polygamy Technology for understanding the surrounding environment, supporting safe driving and overcoming the drawbacks and lack of humanity. The absence of full information is not a big problem in the Polygamy Technology.

Neural network

The absence of full information is not as big a problem in neural networks. The neural networks consist of a set of synapses, as follows: 1) A weight (strength) In order to affect the neurons and access to Knowledge. 2) Net Input (adder). 3) Function Activity (f_{AN}), and 4) A Bias it's called a threshold. It is an external parameter of artificial neurons determine and adjust the values of the weights (w_i , Synapse) to achieve a certain criteria. The neuron is a simple calculator, where enters one or more input and generate one or more outputs. Every input has a weight (w_i , Synapse) which modifies a strength of each input. The Functional Activity (f_{AN}), for learning and approximation expectations through the application of nonlinear equations. We used some types of Function Activity, as follows:

- a) Piecewise-Linear Function

$$F_{AN}(net - \theta) = \lambda(net - \theta).$$

λ = slope parameter of the function(Tangent)

- b) Step Functions

1. Step functions

$$F_{AN}(net - \theta) = \begin{cases} \gamma_2, & net < \theta \\ \gamma_1, & net \geq \theta \end{cases}$$

Where γ_1, γ_2 is scalar output values.

2. Heaviside Function or Threshold Function

$$f_{AN}(net - \theta) = \begin{cases} 0, & Net - \theta < 0 \\ 1, & Net - \theta \geq 0 \end{cases}$$

- c) Ramp Function

$$F_{AN}(net - \theta) = \begin{cases} \gamma & , net - \theta \geq E \\ net - \theta & , -E < net - \theta < E. \\ -\gamma & , net - \theta \leq -E \end{cases}$$

- d) Sigmoid Function

$$F_{AN}(net - \theta) = \frac{1}{1 + e^{-\lambda(net - \theta)}}.$$

Where λ (increase) is the slope parameter of the Sigmoid Function.

Intuitionistic Fuzzy Neural Network

We used the Neural Network (NN) with Intuitionistic fuzzy information and that is the reason for calling it the Intuitionistic Fuzzy Neural Network (IFNN). Synapses, consists of ordered pairs of real numbers from set [0, 1]. IFNN consist of a set of synapses, as follows: 1) Single-input neuron (P_{ij}) of an Intuitionistic Fuzzy Feed Forward Neural Network (IFFFNN), 2) Threshold (Bias, θ), 3) Function Activity (f_{AN}), and 4) Intuitionistic Fuzzy Weight (IFW).

Genetic Algorithms

The traditional methods are not sufficient and there is no programmatic method is employed to determine the best solutions, therefore, we use genetic algorithm. A genetic algorithm is derived from a concept of Darwin's theory of evolution, which rely on analogies to natural processes and biological evolution (natural selection) which is based on survival of the fittest, where it's well in the search for large areas and non-linear. The idea of the genetic algorithm is based on to evolve an optimal solution in selecting individuals (produce the Parents) on each step at random, then used later to produce successive generations of a population (produce the children or offspring) undergoes a sequence of transformations like reproduction, mutation type and crossover type. The offspring is expected to perform better than the previous generation. Offspring (new generation) is repeated until we get the best fitness (copies) that means an intelligent search for a solution from a nearly infinite number of possible solutions. A genetic algorithm useful in idealism control and traffic management, through control on cycles, offsets, splits and phase orders, which leads to improves green color by extending the time and organize the traffic light in real time. Fitness function provides the value of meaningful, measurable and comparable in the traffic. The traffic light is divided into a set of genes (many parameters) which are queued, dense, green and red light times and important vehicles which have the priority such as Ambulance, firefighter, and the Police in a road and the intersections.

The Working Principle of Genetic Algorithms

To read how the GA works, it is expressed, as follows: 1) Creation of many individual solutions randomly, to form an initial population. 2) The size of the population contains several hundreds or thousands of possible solutions which depend on the nature of the problem. We select from initiated the population. 3) A proportion of the existing population is selected during each successive generation, to breed a new generation. 4) Individual solutions are selected through a fitness based process, where fitter solutions are more likely to be selected. We take into account a number of things which are as follows: 5) Find the solution with the maximum value of the fitness. 6) Access to the maximum number of generations. 7) Access to the time is allowable.

GENETIC FUZZY SYSTEMS

The Genetic Algorithms (GA) with Fuzzy Systems (FS), it is called Genetic Fuzzy Systems (GFS). Fuzzy logic is based on the knowledge or information which is imprecise and uncertain. It is not able to learn, adapt, and compute by the parallel way, but depend on information which is imprecise and uncertain, so we use Genetic algorithm at the same time it has lack of flexibility, and does not interact and represent the knowledge like a human which is existed in Fuzzy logic that why we use in this thesis, Fuzzy logic and genetic algorithm to complete each other. GFS tries to perform an intelligent search to find an inference from a nearly infinite number of possible solutions by creating new generations. We used the GFS, even we can the learn from experience and the ability to adapt.

USING GA With NN TO TRAIN

We used the Genetic Algorithms (GAs) with Neural Networks (NN), it's called Genetic Algorithms with Neural Networks (GA-NN). Overcome of some disadvantages of the back propagation Network to learn. We use GA for learning and minimize the error in artificial neural network. We used the Evolutionary Algorithms like the Genetic Algorithms (GAs) to train with Neural Networks (NN), during the least Mean Square (LMS) and Directed Random Searches, instead BPN, during numerical analysis to derive weights for learning (training). It always heads towards a solution by lowering the error of the network. The search starts from random points, and slowly converge to a resolution. We collect the weights in the neural network and making one string (chromosome), so this string is used in the GA as a member of the population where each string represents the weights of a complete network. Advantages of GA-NN algorithms are able to find the environment quicker than other strategies (NN) of classical optimal solution such as BPN.

Neural Networks-Fuzzy Systems

Researchers have felt for a long time that the neurons are responsible for the human capacity to learn. Artificial Neural Network (ANN) when fusing the two approaches of ANN with Fuzzy Logic, it is called Fuzzy Neural Network (FNN). Merging FL into NN allows in the solution, cognitive uncertainties in a similar way to treat humans. It is possible to overcome the deficiencies by utilizing a two approach (FNN) instead

of applying a single approach (ANN or Fuzzy). Neural Networks and logic Fuzzy are used to deal with uncertainty to be able to flexibility and adapt to uncertain environments, It aspires to develop new architectures to improve learning and enhancing the level of skills of knowledge representation. We applied in our thesis, two types of Fuzzy neural network, as follows: 1) Neurons with LR-Representation of Fuzzy Sets and 2) Neurons with Fuzzy Controller Systems.

Fuzzy Neural Network with Genetic Algorithm

Mating with Fuzzy logic (FL), Artificial Neural Network (NN) and Genetic Algorithm (GA) has led to the emergence of the most popular approaches is machine learning and the optimal. It's called Fuzzy Logic and Artificial Neural Networks with a Genetic Algorithm (FNN-GA). We used the GA instead of back propagation with Artificial Neural Networks as a way to find a good set in inference and a less complex.

Intuitionistic Fuzzy Neural Network with Genetic Algorithm

Intuitionistic Fuzzy Neural Network with Genetic Algorithm (IFNN-GA) consists of ordered pairs of real numbers from set $[0, 1]$. We used the Fuzzy Neural Network and Genetic Algorithm for the results Inference Engine, as shown Figure 1.

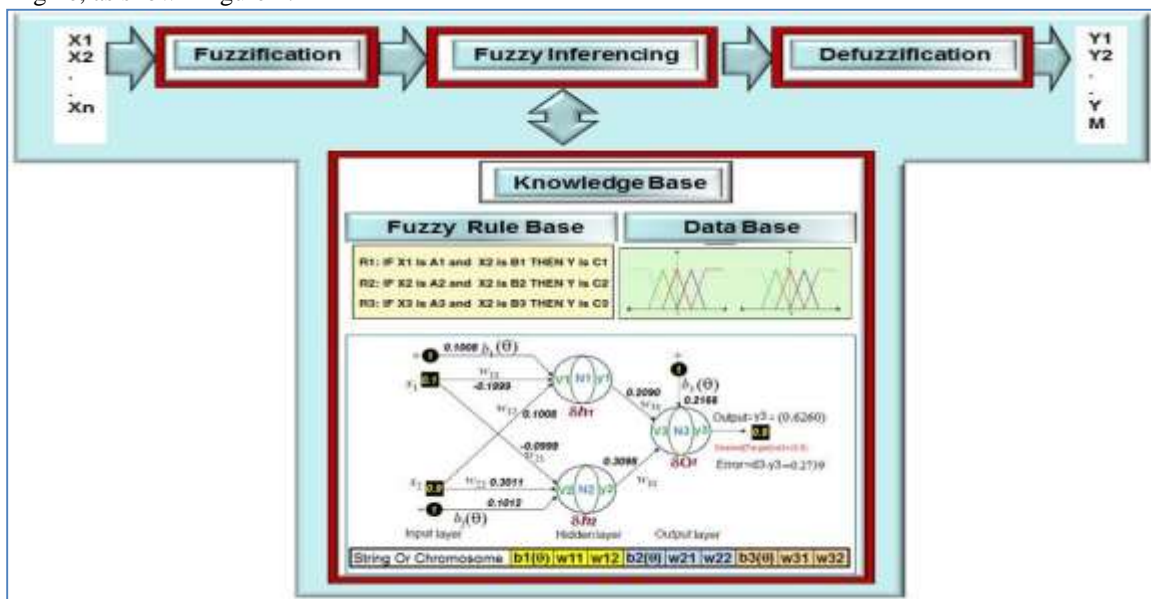


Figure 1: Intuitionistic Fuzzy Neural Network with Genetic Algorithm

CHAPTER SEVEN: SIMULATION UNDER POLYGAMY TECHNOLOGY

Experiment of Fuzzy Graph

The Fuzzifying Function, Support and α -cut

We choose a road that does not contain density of vehicles in tourist area is Baptism, as shown in Figure 2.



Figure 2: (A) The density of vehicles in Day and Night, (B) Baptism in the area of Wadi Kharrar in Jordan.

We conclude on the way is avoid the road one at Night and the road two and three at Day.

Study of the Tourist Area, a Baptism

We used the Baptism area to identify areas of congestion, and choose the road without any delay, with commitment in speed of assessed road and avoid risks.

Experiment of Fuzzy Expert System & Intersection

1) Termination and Extension on Traffic light

The Fuzzification input data are Queue Green (QGi), The Queue Red (QRi) and the Arrival Green (AVi), as shown in Figure 3 and Table I.

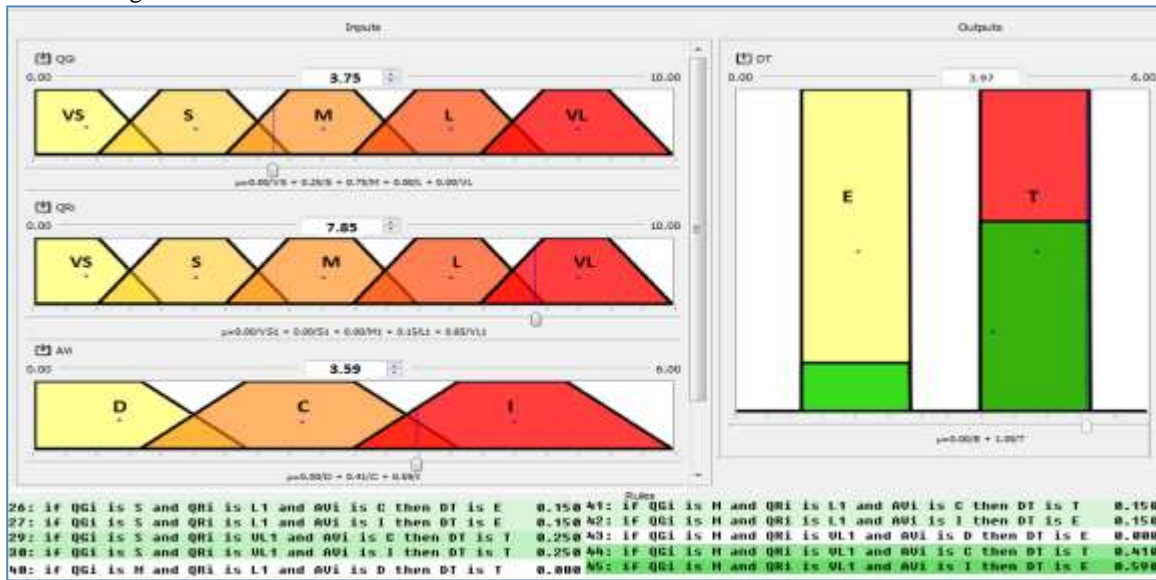


Figure 3: Fuzzy Sets for Input (Qgi, Qri And Avi) and Output (Termination And Extension).

Table I: Fuzzification of Input Traffic Data.

NUM	Input of Membership	Traffic Data	Fuzzified Category	Membership Grad
1	QGi	3.75 Veh/Lane	Small	0.25
			Medium	0.75
2	QRi	7.85 Veh/Lane	Large	0.15
			Very Large	0.85
3	AVi	3.59 Veh/Sec/Lane	Constant	0.41
			Increase	0.59

2) The Basic Rules of Fuzzy

Queue Green (QGi) × The Queue Red (QRi) × The Arrival Green (AVi) = 75 rules, that the fuzzy rules are of the following numbers: (26, 27, 29, 30, 41, 42, 44, and 45), as shown in Table II.

Table II: Fuzzy Rules Contains Three Inputs .

NUM	Fuzzy Rule
26	If QGi is Small and QRi is Large and AVi is C Then DT is an Extension
27	If QGi is Small and QRi is Large and AVi is I Then DT is an Extension
29	If QGi is Small and QRi is Very_Large and AVi is C Then DT is Termination
30	If QGi is Small and QRi is Very_Large and AVi is I Then DT is Termination
41	If QGi is a Medium and QRi is Large and AVi is C Then DT is Termination
42	If QGi is a Medium and QRi is Large and AVi is I Then DT is an Extension
44	If QGi is a Medium and QRi is Very_Large and AVi is C Then DT is Termination
45	If QGi is a Medium and QRi is Very_Large and AVi is I Then DT is an Extension

3) The Inference Engine

An inference job is the process of converting (translate) the Input values (Fuzzy) to the Output values (real crisp). We used the maximum and the minimum composition method, as shown in Table III.

Table III: Fuzzy Inference Using Max-Min Composition Method.

Fuzzy Rule	Input Functions Of Membership			Output	Min composition	Max
	QGi	QRi	AVi			
26	Small	Large	Constant	E	Min (0.25,0.15,0.41) = 0.15	0.59
	0.25	0.15	0.41			
27	Small	Large	Increase	E	Min (0.25,0.15,0.59) = 0.15	0.59
	0.25	0.15	0.59			
29	Small	Very_Large	Constant	T	Min (0.25,0.85,0.41) =0.25	0.41
	0.25	0.85	0.41			
30	Small	Very_Large	Increase	T	Min (0.25,0.85,0.59) = 0.25	0.41
	0.25	0.85	0.59			
41	Medium	Large	Constant	T	Min (0.75,0.15,0.41) = 0.15	0.41
	0.75	0.15	0.41			
42	Medium	Large	Increase	E	Min (0.75,0.15,0.59) = 0.15	0.59
	0.75	0.15	0.59			
44	Medium	Very_Large	Constant	T	Min (0.75,0.85,0.41) = 0.41	0.41
	0.75	0.85	0.41			
45	Medium	Very_Large	Increase	E	Min (0.75,0.85,0.59) = 0.59	0.59
	0.75	0.85	0.59			

Fuzzy Set to Decision-Making

The Fuzzy logic decision will extend or not extend (terminate) in current green phase based on the traffic conditions. It's based on the result shown in the previous Table III.

E: Max (0.15, 0.15, 0.15, 0.59) = 0.59.

T: Max (0.25, 0.25, 0.15, 0.41) = 0.41.

Max (T, E) = (0.59, 0.41) = 0.59.

Finally, the final decision will be the **Extension**.

Experiment of Interval-Valued Intuitionistic Fuzzy

The best ways that the ambulance will be chosen under all weather conditions and the appropriate speed to reach to the nearest hospital from among hospitals. There are three types of roads and three hospitals. A) Agriculture. B) Mountain. C) Within The City.

The Relationship Between Road and Driver, as follows:

The degrees are the relationship between Road and Driver (Road's degrees, FR_Q), consist of: 1) $\mu_Q(t, s)$: the Road (t) does appear with Driver (s), to change shape or texture road, boundary road (edges) and shadows. 2) $VQ(t, s)$: the opposite from μ_Q , namely the degree to which the Road (t) does not appear with Driver (s). **The Relationship Between Road And Arrive (Hospital's Degrees) (FR_R)**, as follows: FR_R indicates to the degree to choose the hospital, where rely on time, it consists of two parameters: 1) $\mu_R(c, t)$: indicates the degree to reach Hospital at the fastest time along the road. 2) $VR(c, t)$: the opposite from μ_R , as shown in Figure 4.

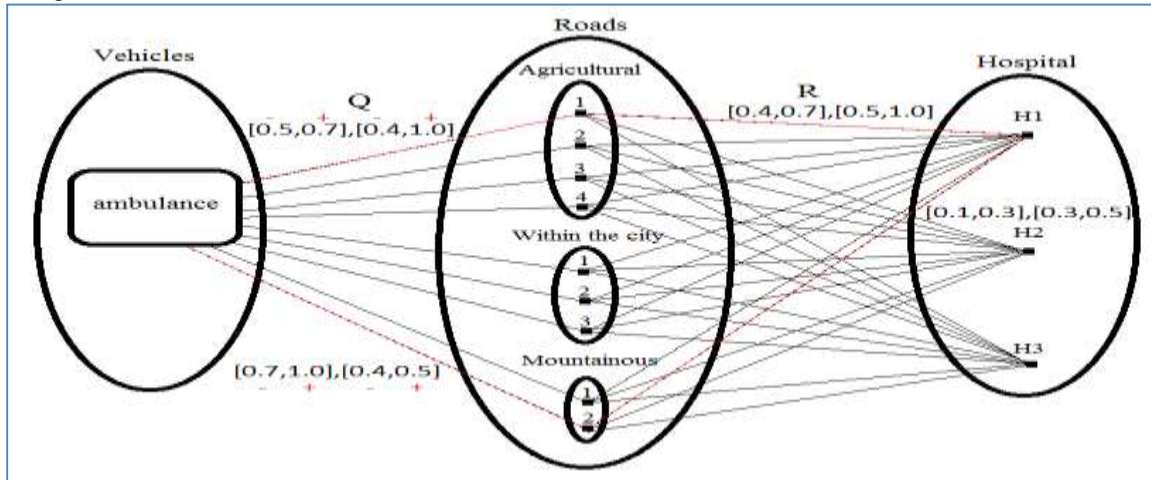


Figure 4: The Composition for Ambulance to Get to the Nearest Hospital.

Experiment of the Intuitionistic Fuzzy Set (IFS)

Three Models to Extract the Best Ways: The best way is the first hospital and the type of road, agricultural, and then to the internal road to the second hospital, and so on, as shown in Table IV.

Table IV: Choose the best ways of among three types (CN, IVIFS and IFD)

Interval-Valued Intuitionistic Fuzzy Set						
1	Hospital		one	Two	Three	Distance (L)
	Distance (L)	Agricultural	0.8	0.29	0.25	0.21
		Within the city	0.12	0.7	0.26	0.15
		Mountainous	0.11	0.16	0.13	0.14
Distance (L)		0.11	0.18	0.22		
Intuitionist Fuzzy database						
2	Vehicle	Hospital	Roads	Times		
	Ambulance	Hospital one	Agricultural	March 06:00 AM		
3	Cut Node					
	Mountainous					

We used, the types of Intuitionistic fuzzy set, and concluded, as follows:

- We used the Intuitionistic Fuzzy Database (IFDB) to reduce doubt, therefore choosing the best ways from the cities of Jordan. The best way is the first hospital and the type of road, agricultural.
- Interval-Valued Intuitionistic Fuzzy Sets (IVIFS), there are three types of roads and three hospitals, as follows: { within the city, mountain, agriculture }. We arrived to the nearest hospital from among hospitals. It is more general, comprehensive and powerful tool than fuzzy set, such as α -Cut, Cut Node and a the Intuitionistic Fuzzy Database (IFDB).

Experiment of GENETIC FUZZY SYSTEMS (GFS)

One Cycle at Intersection Translates to Chromosome (Four of the Genes), as shown in Figure 5.

		Phase 1 (Gen)								Phase 2 (Gen)							
		GTV	Vroad_2	W2	Vroad_3	W3	Vroad_4	W4	Vroad_1	W1	GTV	Vroad_3	W3	Vroad_4	W4		
Chromosome 1	Dec second	5	3	15	7	1	9	1	8	1	45	20	1	13	1		
	Dec second	5	45		7		9		8		45	20		13			
	Binary	101	101101		111		1001		1000	101101		10100		1101			
	Gray	111	111011		100		1101		1100	111011		11110		1011			
	V_{phase_1}	61								41							
	The rate of cars	15.25								10.25							
	Y	930.25								420.25							
Fitness function	0.1189								0.0537								

Phase 3 (Gen)								Phase 4 (Gen)								Allele
Vroad_1	W1	Vroad_2	W2	GTV	Vroad_4	W4		Vroad_1	W1	Vroad_2	W2	Vroad_3	W3	GTV	Fitness Function	
14	1	7	1	85	3	20		10	1	4	1	5	25	125	0.6176	
14		7		85		60		10		4		125	125			
1110		111		1010101		111100		1010		100		101110111	1111101			
1001		100		1111111		100010		1111		110		1000011	1000011			
81								139								
20.25								34.75								1955.25
1640.25								4830.25								7821
0.2097								0.6176								0.6176

Figure 5: One Cycle at Intersection Translates to Chromosome (Four of the Genes).

We used the GFS in Intersections, and concluded, as follows: 1) Reducing the average of waiting vehicle time, 2) Improving the average vehicle speed, 3) Reducing the congestion and operational costs.

Experiment of GA-NN and IFNN-GA

In order to find out all the existing characters on the plate of the vehicle we use Polygamy Technology and a representation of ASCII with Successive input. IFNN-GA receives the character and shows the primary key which refers to the image in the database, as shown in Figure 6.

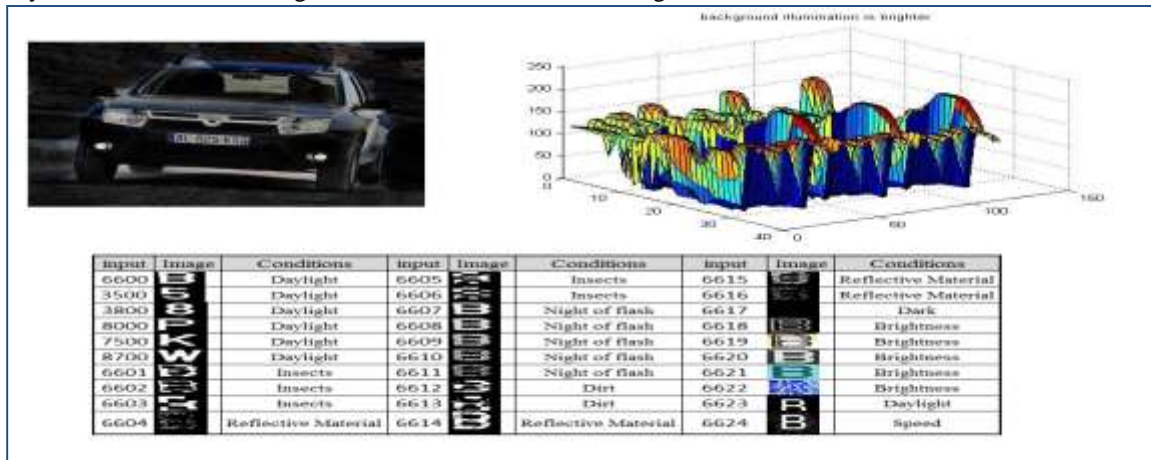


Figure 6: Data Base containing all License Plates and input image.

We Compared between BPN and IFNN-GA, as follows: IFNN-GA based on number of iteration even reach the actual data, we used seven iterations to reach less error (predicted). BPN, we used 124 iterations to reach less error (predicted). IFNN-GA led to learn from experience, a less complex, incorporate human knowledge, the ability to adapt and the optimization is better than BPN, as shown in Figure 7.

We used the IFNN-GA in Intersections and the results of experiments, as follows: 1) We monitor the vehicle after analyzing and understanding the vehicle plate to find stolen vehicles. 2) Find available parking spots (gain time) to solve the hassles of parking. 3) Save fuel by reducing travel time. 4) Protection from theft.

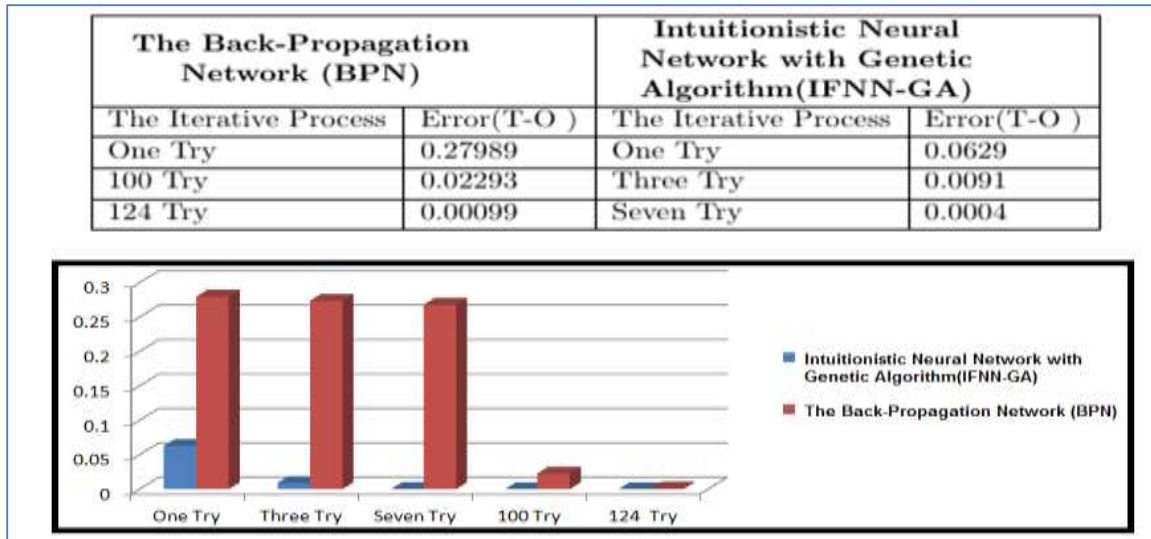


Figure 7: The Compare Between(BPN) and (IFNN-GA).

CONCLUSIONS

Current methods for traffic management, monitoring, and control are not effective enough. In this study, it has found an effective method to be completely effective where shows the best available and speedy ways to assist drivers in real time. The study and application of fusion theory to create system able for learning and the capability of high performance even if the decrease in image resolution and imprecise and uncertain data. Using a system fusion or polygamy technology to control the traffic by using a new technology to be effective and change a sequence of traffic. We used the infrastructure by improving and manipulating in time with maintaining on the infrastructure. In our study, results have demonstrated the feasibility and validity of the proposed The Intuitionistic Fuzzy Logic with Neural Network and Genetic Algorithm. In order to understand more of the surrounding environment of the objects and reach the best choice for the management of traffic in real time. We reached to the results in this thesis, by many of the topics, as follows:

- **Intersection the Road:**

- 1) We used the intersections leg, multi-leg, and multi-forked, on the dynamic approach.
- 2) Lanes at the intersection of the street will be converted to the Graph, after that the graph will be converted to Complement Fuzzy Graph (CFG), to extract all phases at the intersection to avoid any collision.
- 3) We take our data from databases stored and converted from binary to Gray code and vice versa, to create a chromosome by using Genetic Algorithms (GA).
- 4) We used the Genetic Algorithms (GA), we are improving the traffic light timings, in other words extension of the green time.
- 5) A length of the cycle depends on emergency cases, that mean vehicles which have the priority to cross the intersection. We will give every vehicle a weight to avoid delays, justice, and give the security for the city such as Ambulance, fire fighter, and Police, 15,20 and 25, respectively.
- 6) Vehicle surveillance by a traffic light in order to analyze and understanding the vehicle plate to find the violators. In our study, in intersections, when we used GFS: Improving the average vehicle speed, and reducing the congestion and operational costs.

- **Parked Vehicles:**

- 1) In our study, we take from databases all the plates of vehicles and compare with plates of vehicles, which in parked vehicles or moving on the roads, through understanding plates of vehicles and remove any impurities (obstacles) such as lighting or insects.
- 2) We were able Finding vacant spaces in parked vehicles and told the drivers about vacant spaces, this method reduce congestion effort and time, it is either empty (vacant space), or occupied or reserved for handicapped or VIP.
- 3) We monitor the vehicle after analyzing and understanding the vehicle plate to find stolen vehicles. Advantage parking management in our study:
 - 1) Find available parking spots (gain time) to solve the hassles of parking.
 - 2) Save fuel by reducing travel time.
 - 3) More fun by providing updated information and a rapid spread of information.
 - 4) Protection from theft.

- **Study of the Tourist Area, a Baptism:**

In our study, we used the Baptism area to identify areas of congestion, and choose the road without any delay, with commitment in speed of assessed road and avoid risks, we concluded that: 1) through on Approximate forecasting in unpredictable situations such as changes in illumination and shadows in the sunset and sunrise in the four roads. 2) Through on collecting information about the four roads in the day and night, to identify areas of congestion, by Support and α -Cut.

- **We have proposed three models to extract the best ways:**

In our study, three models have been proposed to extract the best ways: 1) we used Support and α -Cut for identifying roads of congestion. 2) We specified Fuzzy Graph (Connectedness) in identifying or find areas of congestion (delays or obstacles), it's called Cut Node (CN) and this observe when avoiding the node became the fastest way to reach to the target (endpoint). 3) The Intuitionistic Fuzzy Set (IFS), consists of two types: a) We used the Intuitionistic Fuzzy Database (IFDB) to reduce doubt, therefore choosing the best ways from the cities of Jordan. In our study, we have two cities: {Amman and Irbid}, there are four types of roads between two cities: {Agricultural, Mountainous, Internal and Tunnel}. b) Interval-Valued Intuitionistic Fuzzy Sets (IVIFS) In our study, there are three types of roads and three hospitals, as follows: {within the city, mountain, agriculture}. We arrive to the nearest hospital from among hospitals. It is more general, comprehensive and powerful tool than fuzzy set, such as α -Cut, Cut Node and a the Intuitionistic Fuzzy Database (IFDB).

- **Roads Detection Systems:**

In our study, we used the Roads detection systems such as (loop detection, video camera, cellular automaton (CA), and microwave), We were able to know what is happening on the roads, such as: 1) We were able to detect the traffic stats, such as changing of behavior of objects, the maximum speed, and acceleration (arrival and departure rate of vehicles). 2) We were able to determine the external environment such as weather conditions, varying lighting, ubiquitous shadows, dirt balls, dirt and insects. 3) We were able to determine the wide variation of the size, shape or texture such as change of a vehicle plate and roads. 4) In our study, we were able to determine Fuzzy along roads through, when equal one, that means a movement of vehicles on roads in their best cases (without any delay), and when equal zero, that means any vehicle has not to pass on the road (closed roads).

- **Inference to Make a Decision:**

We used the Rule-Based expert system by Modus Ponens and Modus Tollens, where consists of three components: the knowledge base, the database and the inference engine (conclusion). Inference, in our study, his methods and his models, are as follows: 1) His methods: We applied this method for improving Inference engine, that make us to take best of decision, through four methods: Mamdani method, Larsen method, Tsukamoto method, and TSK method. Inference procedure is called the Compositional Rule of Inference, by two factors: a) Singleton input (implication operator). b) Fuzzy input (composition operator). 2) His models: a) The Genetic Algorithms (GA) with Fuzzy Systems (FS), it is called Genetic Fuzzy Systems (GFS). It tries to perform an intelligent search to find an inference from a nearly infinite number of possible solutions by creating new generations. We applied GFS for improving Inference engine, which we can adapt and take best of decision. b) We used NN-GA to train, learning and minimize the error for reach to more intelligent inference, during the least Mean Square (LMS) and Directed Random Searches, instead BPN, during numerical analysis to derive weights. We collect the weights in the neural network and making one string (chromosome), so this string is used in the GA as a member of the population where each string represents the weights of a complete network (complete fuzzy graph). We applied NN-GA for improving Inference engine, which we can learn from experience, the ability to adapt and take best of decision. c) We applied FNN for improving Inference engine, which we observe: deal with uncertainty to be able to flexibility and adapt to uncertain environments, Inference engine became able to enhancing the level of skills of knowledge representation led to learn from experience, the ability to adapt and take best of decision. Also became more transparent (that means self-adapting, self-organizing and self-learning). d) IFNN-GA based on number of iteration even reach the actual data, we used seven iterations to reach less error (predicted). BPN, we used 124 iterations to reach less error (predicted). We used the IFNN with GA to minimize iteration through the least Mean Square (LMS). GA takes less than half the computation of the Back Propagation Network (BPN) with artificial neural networks. We were compared between BPN and IFNN-GA, when we applied IFNN-GA led to learn from experience, a less complex, incorporate human knowledge, the ability to adapt and the optimization is better than BPN.