

Design of Genetic-Fuzzy Based Diagnostic System to identify Chikungunya

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Abstract - Medical Diagnostic system is very crucial in generating accurate and rapid diagnosis of disease. **Particularly, in today's era, there are several diseases whose symptoms are quite similar in initial stage. But at the same time, initial level diagnosis is also required to be accurate. The paper discusses diagnostic system for identifying disease of Chikungunya. Integration of Genetic Algorithm and Fuzzy Logic is utilized in designing intelligent system. The designed intelligent system is capable to provide diagnosis whether patient suffers from Chikungunya or not. The system is trained with training data set designed from incorporating medical expert's knowledge. The paper discusses working characteristics and advantages as well as limitations of Genetic Algorithm and Fuzzy Logic. Benefits of Genetic-Fuzzy hybridization are also narrated. The paper presents detailed discussion of learning strategy of Genetic-Fuzzy hybrid system. The prediction accuracy of designed intelligent system is explained. Finally, the paper concludes with accuracy of result provided by intelligent system.**

Keywords: Diagnostic System, Genetic-Fuzzy hybridization, Intelligent System, Prediction Accuracy

1. Introduction

Intelligent system is a specific type of computerized information system that supports automatic decision-making activities. The main aim to design intelligent system is to provide automatic decision making for given data. In today's technological era, intelligent decision support has become a need for every type of application. The significance in this type of research work is determination of attributes and their initial level of input data set. The paper proposes an intelligent decision support system using genetic-fuzzy integration. Genetic Algorithm and Fuzzy logic has become very useful techniques in designing machine learning systems. The prime advantage of integration of Genetic-Fuzzy system is low cost solution and ease of implementation. The paper presents working characteristics of Genetic Algorithm along with advantages and limitations. Fuzzy logic provides handling of uncertainty and imprecision for real life application. The paper provides working

characteristics of Fuzzy Logic along with advantages and limitations. Advantages of hybridization of Fuzzy Logic and Genetic Algorithm are presented.

The paper represents application development for diagnosis of Chikungunya fever of a patient using intelligent system based on Genetic-Fuzzy hybridization. It has been observed that there are various intelligent systems developed to identify specific diseases such as types of cancers, heart failure, etc. but there has not yet any automatic decision support system developed which identifies initial diagnosis of fever of Chikungunya. It is very crucial to identify exact type of fever as there are similar kinds of symptoms observed in different disease. But the severities of such symptoms are different i.e. High, Low or Medium. Some time it happens that laboratory test even can-not generate exact result in very early stage of some diseases. The paper represents detailed discussion of designing of the intelligent system which provides solution for such kind of problem, where initial diagnosis is difficult without laboratory test. The paper provides discussion of training data set by designed by interviewing medical expert who provides diagnosis whether patient is prone to fever of Chikungunya or not. The paper also discusses prediction accuracy of system generated results.

The initial section of the paper represents the significance of Genetic-Fuzzy hybrid approach. The structure of Genetic Algorithm is presented along with its components. The paper extends benefits of Genetic Algorithm. Several limitations of Genetic Algorithm are also presented. The second section represents the need of Fuzzy System along with discussion of characteristics of fuzzy logic. It explains multiple advantages of Fuzzy system. This section of the paper also extends limitations of Fuzzy logic. This leads to the need of Genetic-Fuzzy hybridization. The third section of the paper represents the significance of hybridization of Genetic Algorithm with Fuzzy Logic. The fourth section represents the application development for diagnosis of Chikungunya disease. The designing components of Genetic-Fuzzy Diagnostic system are explained along with detailed description of sub components. The result of diagnostic system is discussed by presenting prediction accuracy of system. The concluding part of the paper presents significance of designed intelligent system along with future work of the diagnostic system of Chikungunya.

parent chromosomes will be processed further to generate new children chromosomes.

The broad structure of GA is shown in Figure 1. The working structure of Genetic Algorithm is explained as under.

The strength or fitness of each chromosome is checked by various designed criterions. So as to find the strength of chromosome, the fitness measurement criterions are designed. With the help of selection operation, the most fit or strongest solutions will work as parents for next generation. The weakest or least fit solution will die out. In order to increase multiple generations different genetic operators are applied. Eventually, the case of final convergence is reached. In such case, if the population has converged and not produced child chromosomes which are different than previous generations' off-springs, the algorithm itself is said to have converged to a set of solutions to the problem at hand.

2.3 Advantages of GA

GA is efficient in playing multiple roles apart from searching capabilities. These roles includes artificial evolution in generating new and optimal solutions, searching multiple solutions simultaneously, providing complex level optimization, hybridization with other constituents of soft computing such as Fuzzy Logic, Neural Network, etc. The major benefit of GA is that it can be used to find optimized values from large search space as well as makes system able to learn [2]. Genetic Algorithm provides many advantages which make Genetic Algorithm a very prominent search and optimization method [1,2]:

- Genetic Algorithms can be easily interfaced to attainable simulations and models; being one of the prominent representatives of evolutionary computation, Genetic Algorithm satisfies the requirement providing optimum solution.
- Genetic Algorithm is easy to hybridize and easy to understand;
- Genetic Algorithm uses little problem specific code;
- Genetic Algorithm is modular, separate from application;
- Genetic Algorithm is capable to obtain answers always and gets better with time; and
- Genetic Algorithm is inherently parallel and easily distributed. Hence, GA is highly successful in providing solutions for parallel processing problems.
- Genetic Algorithm optimizes with continuous or discrete variables;
- Genetic Algorithm deals with a large number of variables;
- Genetic Algorithm provides a list of optimal variables, not just a single solution;
- Genetic Algorithm encodes the variables so that the optimization is done with the encoded variables; and

- Genetic Algorithm works with numerically generated data, experimental data, or analytical functions.

2.4 Limitations of Genetic Algorithm

According to Maxim, several weaknesses of Genetic Algorithms have been noticed such as [3]:

- Domain knowledge cannot be directly documented using GA structure.
- GA requires entire population to work (takes lots of time and memory) and may not work alone well for real-time applications.
- GA cannot deal with imprecision and uncertainty which are considered the basic requirement of real life applications.

However, one of the significant limitations of GA; shown in an inability of storage and handling imprecision.

3. Fuzzy System (FS)

A fuzzy inference system—or simply a fuzzy system- is a rule-based system that uses fuzzy logic, rather than Boolean logic, to reason about data. Fuzzy logic is a computational paradigm that provides a mathematical tool for representing and manipulating information in a way that resembles human communication and reasoning processes [4]. In order to solve problems of real life applications, it is required to deal with imprecise or inexact knowledge. Prof L. Zadeh proposed the theory of Fuzzy Logic which is designed to handle uncertainty and imprecision. According to Zadeh, degree of knowledge representation can be enhanced with the use of linguistic variables [5]. Conventional approaches of knowledge representation are based on bivalent logic, which is associated with a serious shortcoming: inability to deal with the issue of uncertainty and imprecision. Fuzzy Logic may be viewed as an extension to classical logic systems providing an effective conceptual framework for dealing with the program of knowledge representation with uncertainty and imprecision. It is similar to human reasoning. Fuzzy systems are based on Fuzzy Logic and fuzzy set theory which provide a rich and meaningful addition to standard logic. It is found that the fuzzy logic-based approach to solving problems in control is proven excellent in those systems which are very complex, highly nonlinear and with parameter uncertainty.

The major reasons behind fuzzy systems development are enlisted as follows [6, 7]:

- It is not required to have high level of pre-requisite knowledge of formal Fuzzy Logic theory. Even with Little knowledge of Fuzzy logic theory, Fuzzy systems can be designed.
- Fuzzy Systems can support broadly unstable load conditions. Such conditions can be treated with crucial parameter changes.

- It is highly desirable to implement the theory of Fuzzy Logic for industrial processes where the controlled cycle time may operate over an extended period.
- Fuzzy system mimics human reasoning and hence it is easy to design Fuzzy Rule Base System with linguistic knowledge.
- A simple mathematical model can be designed in form of Fuzzy system which is relatively simple, fast, and adaptive compared to complex logical formulations.
- It is easy to implement precisely difficult design objectives using linguistic or descriptive rules with the help of Fuzzy Logic,
- In addition to all stated benefits, it has been also observed that FL has the potential to significantly reduce not only the knowledge acquisition cost but also the computational cost [8].

3.1 The Theory of Fuzzy Logic

Fuzzy Logic is a multi-valued logic introduced by L. Zadeh in 1965 [9]. Classical logic is based on crisp set. Fuzzy systems are based on Fuzzy Logic; a generalization of conventional (Boolean) logic that has been extended to handle the concept of partial truth values between “Completely True” and “Completely False”. The main idea of the fuzzy logic is to capture the vagueness of the human thinking and to express it with appropriate mathematical tools [10].

3.2 Degree of Membership

The values of a membership function, called membership degrees or grades of membership, precisely specify to what extent an element belongs to a fuzzy set, i.e. to the concept it represents. The theory of conventional logic (Bivalent Logic) provides crisp membership values. These values consist of either true or false (0 and 1). In such system, it is not possible to process intermediate values or exact values. Figure 2 (a) and Figure 2 (b) represents degree of membership for crisp set and Fuzzy set respectively.

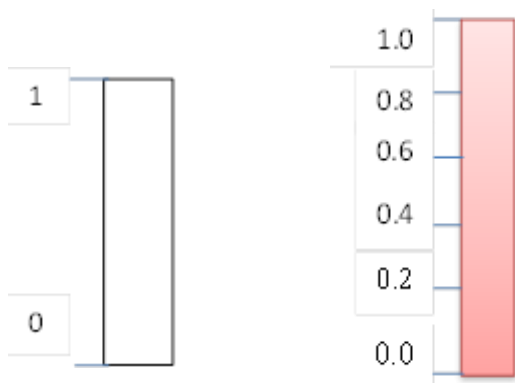


Figure 2[a]: Degree of Membership for Crisp Set

Figure 2 (b): Degree of Membership for Fuzzy Set

A crisp set is defined by a bivalent truth function which only accepts the values 0 and 1 meaning that an element fully belongs to a set or does not at all, whereas a fuzzy set is determined by a membership function which accepts all the intermediate values between 0 and 1.

Fuzzy Logic allows intermediate values to be defined between the two aforementioned conventional evaluations. In real life applications, it is observed that usually real processing requires handling vague values. Eg. Rain is heavy or light, Temperate is low or high or highest, Clouds are dark or light, etc. It is not possible to identify degree of measurement using such linguistic forms using the theory of bivalent logic because bivalent logic can only process either 0 or 1. The degree of membership is 0 means either Rain is not there and the degree of membership “1” means that Rain is there. But the level of rain, whether it is medium, high or vary high can-not be identified. Fuzzy Logic provides an easy way to handle imprecision by processing linguistic knowledge representation.

3.3 Crisp Membership Function vs. Fuzzy Membership Function

Crisp, set A in a universe of discourse U can be defined by listing all its members or by defining conditions to identify the elements $x \in A$.

$$A = \{x \mid x \text{ meets some condition}\} \quad (1)$$

The characteristic function, generally called membership function, associated with A is a mapping $\mu_A : U \rightarrow \{0, 1\}$ such that for any element x of the universe, $\mu_A(x) = 1$, if x is a member of A and $\mu_A(x) = 0$, if x is not a member of A. Hence, values of membership in crisp set are either one or zero.

Membership Function of a crisp set

For eg. The crisp set is defined as $A = \{x \mid 10 \leq x \leq 15\}$. The membership of every element in A is defined as $\mu_A(x)$. In crisp set, an element is either residing in set or not residing in the set. In such sets, membership of element is either 0 or 1.

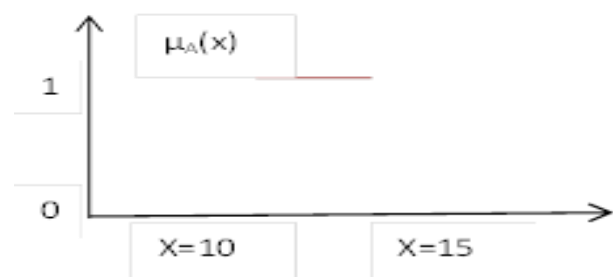


Figure 3: Example of Degree of Membership in Crisp Set

Here, $A = \{10, 11, 12, 13, 14, 15\}$. The degree of membership of each element in A is 1 which is represented using red line as shown in Figure 3.

Membership function of a Fuzzy Set

For e.g ; the fuzzy set is defined as $F = \{x \mid x \text{ is between } 10 \text{ and } 15\}$. In the figure 4, an example value 9 is fuzzified as (i.e. it is assigned the membership value) $\mu_F(9) = 0.7$.

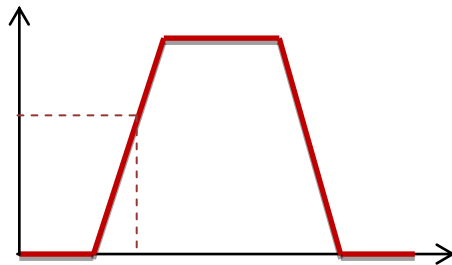


Figure 4: Example of Degree of Membership in Fuzzy Set

Membership functions might formally take any arbitrary form as they express only an element-wise membership condition. However, they usually exhibit smooth, monotonic shapes. The significant reason behind this characteristic is that membership functions are generally used to represent linguistic units described in the context of a coherent universe of discourse [11]:

3.4 Advantages of Fuzzy Logic

Fuzzy logic based system provides following advantages [2].

- Fuzzy Logic based system provides knowledge representation in a human understandable way using the linguistic rules to explain decision processes.
- Fuzzy Logic provides the concept of linguistic labels which is very powerful way of knowledge representation. This type of knowledge representation is closer to human representation (e.g., “high fever” instead of “temperature higher than 40.3 degrees”).
- Linguistic representation such as linguistic concepts and linguistic rules is accompanied by a precise numeric equivalent that is adequate for managing information available in a numeric way.
- In several applications related to non- linear, time-varying, ill-defined systems and also complex systems, the fuzzy systems have been proven very efficient.

3.5 Limitations of Fuzzy Logic

Fuzzy system are designed to handle uncertainty and imprecision in real situation easily. But one of the major limitations of such systems is that they do not provide learning ability [12]. Fuzzy Systems also suffer from inability of adaption characteristics. But the major limitations of fuzzy systems are enlisted as follows:

- Fuzzy Logic is not capable to provide self- learning;
- Fuzzy Logic is not capable to provide adaption capability;

- Fuzzy Logic is incapable to provide parallel computation;
- Fuzzy Logic cannot support optimization; and
- Fuzzy logic can- not capable to strength the solution once it is achieved.

In order to overcome limitations of Fuzzy Logic, evolutionary learning process can be designed to automate Fuzzy Rule Base System (FRBS) design. Particularly in the framework of soft computing, significant methodologies have been proposed with the objective of building fuzzy systems by means of Genetic Algorithm.

4. Advantages of Genetic-Fuzzy Hybridization

The hybridization of different learning and adaptation techniques is required to overcome limitation of individual methods so that synergetic effects through hybridization or fusion of these techniques can be made achievable. Several advantages offered by Genetic Algorithms are stated in last section. Figure 5 narrates advantages of Genetic-Fuzzy integration.



Figure 5: Advantages of Genetic-Fuzzy Hybridization

But at the same time, the major limitation of Genetic Algorithm is that it is not capable to store domain knowledge but Genetic Algorithm can be used to find optimized values for the membership function parameters, particularly when manual selection of their values becomes difficult or takes too much time to attain [13]. Fuzzy Systems also suffer from inability of adaption characteristics as well as inability of self-learning. The advantages of Genetic-Fuzzy hybridization are presented as under:

- The Genetic-Fuzzy Hybrid system is capable to provide evolutionary characteristics;
- The Genetic-Fuzzy Hybrid system generated intermediate solution can be adaptive;
- The Genetic Fuzzy hybrid system can store and handle domain knowledge which is not possible alone by genetic algorithm;
- The Genetic-Fuzzy hybrid system is capable to search optimized solutions as per designed criteria;

- The Genetic-Fuzzy system is capable to provide learning capabilities;
- The Genetic-Fuzzy system is capable to process linguistic knowledge representation;
- The Genetic-Fuzzy hybrid system is capable to process imprecise knowledge which is the major requirement of real life application.

Looking towards the above stated advantages of integration of GA and FL, it is desirable to design hybrid system using GA-FL. It has been observed that in the field of medical diagnosis, there is not any machine learning and automatic system developed which provides decision whether patient is suspected to Chikungunya or any other fever. The primary diagnosis is to be made by system so that patient can have proper treatment from the initial stage of the disease.

5. Proposed System for Diagnosis of Chikungunya

Machine learning techniques have performed a great role in the diagnosis and prognosis of many health diseases. Especially, Genetic-Fuzzy hybrid systems are utilized in diagnosis of most serious illnesses such as breast cancer, diabetes and heart failures [14, 15, 16,17]. Chikungunya is a disease that may not be responsible for high mortality rate as Dengue is but it may cause a disturbance in working of a person. Chikungunya is caused by CHIKV (Chikungunya Virus). In order to diagnosis Chikungunya disease, medical practitioner prescribes several laboratory tests. The results of these tests are capable to identify whether patient suffers from Chikungunya or any other fever [18]. Several classification techniques are built using decision trees, clusters, neural networks, logistic regressions, association rules and Naive Bayes classification. However, prior to this, the dataset has been pre-analyzed. The significance in this type of research work is determination of attributes and their initial level of input data set. This is possible only after analysis of the values and representation in dataset. In the case of the proposed machine learning system, learning mechanism is designed with the help of the medical expert. In order to have identification of type of fever, without any laboratory tests, it is required to have the set of data consists of different types of symptoms. These symptoms include various complaints from user such as Fever, Abdominal Pain, Joints Pain, Joint Swelling, Vomiting, etc [19]. These symptoms can be measured in different scales i.e. Fever is measured using Thermometer and in centigrade but other symptoms such as Vomiting, Abdominal Pain, Joint Pain and Joint Swelling can- not be measured in numerical scales. In the manual system, when patient consult a doctor, he/she is asked several questions regarding complaints and after examining the patient, doctor identifies the disease and recommends the medicines. Similarly in the designed system, the training data set from historical data is designed and expert's opinion is taken on this data set. Later, test data are applied on the evolved rule which generates diagnosis whether the patient suffers from Chikungunya or any other fever.

The main reason to design the proposed system is to have primary diagnosis which is not dependent on any clinical tests. Expert systems are capable to provide diagnosis without help of human experts because the system has been designed with incorporating knowledge-bases. The proposed system is a type of expert system which automatically takes decision to identify whether patient is suffering from Chikungunya or any other fever. Figure 6 represents framework for the diagnosis of fever of Chikungunya.

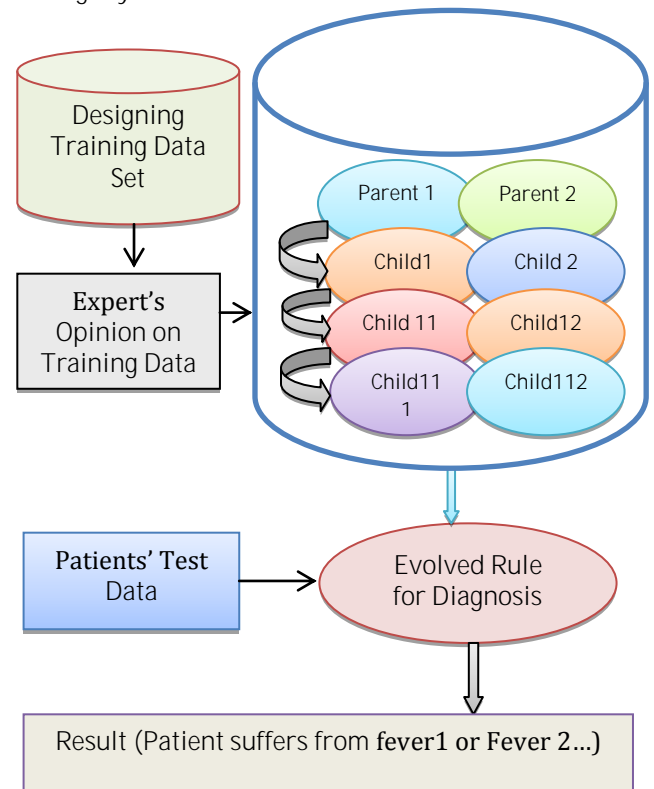


Figure 6: Framework for Diagnostic System for Identification of Types of Fever

In order to identify the type of fever, there are various variables to be considered. These include measurement of fever of patients, Severity of Joints Pain, Joint Swelling, Abdominal Pain, and Vomiting. Usually, patients complain about all the stated type of symptoms in different types of diseases such as Dengue, Chikungunya or any other type of fever [19]. The main aim to select the application area for diagnosis of Chikungunya disease is that, due to similar kind of initial symptoms at patient's initial stage, sometimes it is not possible even by medical expert to diagnose the exact disease without laboratory tests as there are common symptoms in different types of fever. But the severities of various symptoms are different such as Very High, High, Low or Medium. It happens that the laboratory tests even take some time period in order to identify particular diseases like typhoid or Chikungunya. In the case of the stated diseases, it is observed that the result of clinical tests can be accurate after some days. But

at the same time, the accurate primary diagnosis is required to be offered by medical experts without any delay. The proposed expert system is designed to aid medical expert or it can be used in the absence of medical experts to provide accurate diagnosis. The system is designed to identify the type of disease by analyzing patient's various symptoms. The system is trained through historical data set. In order to collect the test data from patients, several linguistic terms are designed. Some symptoms such as Joints Pain, Joints Swelling, Abdominal pain, Vomiting cannot be measured in numeric scales. Fuzzy Logic provides the easiest solution for such kind of real life variables. Using the theory of fuzzy logic, the values of symptoms can be measured using linguistic knowledge representation. The prime advantage of the system is that the programmable logic is almost not needed for the system design if developed using such kind of framework. Table 1 represents variables required to generate decision for identification of fever. The identification of disease of Chikungunya depends on total five variables. The list includes Fever, Joint Pain, Joint Swelling, Abdominal Pain and Vomiting Frequency. The range of values of each of variable is decided by taking information from medical experts. Each variable shown in Table 1 has a specific range. Each of them has been further classified using the theory of Fuzzy Logic. Table 1 also represents possible values of each variable in the form of linguistic terms after fuzzification.

Table 1: Range of Values and Linguistic Representation for Identification of Types of Fever

Sr. No	Variables	Range of Values Degree F	Representation in Linguistic Terms
1	Fever	103-105.5	Very High
		102-103.5	High
		101-102.5	Medium
		100-101.5	Low
2	Joints Pain	7-10	Very High
		6-9	High
		5-8	Medium
		2-5	Low
3	Joint Swelling	5-7	Very High
		4-6	High
		3-5	Medium
		2-4	Low
4	Abdominal Pain	5-7	Very High
		4-6	High
		3-5	Medium
		2-4	Low
5	Vomiting (Frequencies)	5-7	Very High
		4-6	High
		3-5	Medium
		2-4	Low

6. Results and Discussion

The patients are given questionnaires' regarding symptoms of disease. The readings of patient's complaints are captured in form of training data set. The training data set is generated using variables and their linguistic values as shown in Table 2. These data are further utilized for generating medical expert's opinion regarding whether the patient is suspected to Chikungunya disease or any other fever. Due to such type of supervised learning, system is trained for diagnosis whether patient is prone to Chikungunya Disease or not. The system is tested by the end user by providing values of different input conditions which will provide outcome in form of Boolean values i.e. if patient is prone to fever of Chikungunya, answer will reflect "1" and if patient is prone to any other fever, the system will reflect "0". The designed Genetic-Fuzzy hybrid system successfully learns the prediction of the training data set given by medical expert. However, in order to make a further check on the convergence, all these training data scores are applied as the test data to study the response of the system.

Table 2: Training Data Set and Expert's Decision on Data Set

Sr. No.	Fever	Joints Pain	Joint Swelling	Abdominal Pain	Vomiting Frequency)	Expert's Decision About Proneness to Chikungunya
1	High	High	High	High	High	Yes
2	High	High	High	Medium	Medium	Yes
3	High	Medium	High	Medium	Medium	Yes
4	Low	High	High	Low	Medium	Yes
5	Low	Low	High	Medium	Low	Yes
6	Medium	High	Medium	Low	High	Yes
7	High	Low	Medium	High	Low	Yes
8	Medium	High	High	Low	Low	Yes
9	Low	Medium	Low	Low	Low	No
10	Low	Low	Low	Medium	Medium	No
11	Medium	Medium	Medium	High	High	No
12	Low	Low	Low	Low	Low	No
13	High	High	High	Low	Low	Yes
14	Very High	High	Low	Low	Low	Yes
15	Very High	Low	Low	Very High	Medium	Yes
16	Very High	Very High	High	High	High	Yes
17	High	Very High	Very High	Low	Medium	Yes
18	Very High	Very High	Low	Low	Low	No
19	Low	Very High	Very High	Medium	Very High	No
20	Very High	Low	Low	Low	Very High	No
21	Medium	High	High	Low	Low	Yes
22	Very High	Very High	High	Low	Low	Yes
23	High	Low	Low	Low	Medium	No
24	Low	Very High	Low	Medium	Medium	No
25	Very High	Low	Very High	Low	Low	Yes

Table 2 shows representation of expert's opinion on the designed training data set whether patient is suspected to Chikungunya or any other fever. There are total five parameters for patient's health profile which is observed in order to generate the decision. The table represents possible values of patients' health symptoms profile. By observing values of the specified parameters in such profile, the medical expert provides the decision whether patient is suspected to fever of Chikungunya or any other fever. Two choices are considered. Patient is prone to Chikungunya fever? "Yes" or "No". In case of absence of medical expert, the decision can be taken from historical data set stored previously.

Table 3 represents analysis of system's prediction capability. It shows a typical set of test data containing patient's health profile values and expert's decision on the same along with system's prediction on the same data set. Various test data are entered into the system and it is observed that system has generated equivalent results which are matched with expert's decision on training data set. It shows that system has learnt from expert's opinion and the learning mechanism through designed procedure is comprehensive enough.

Table 3: Genetic-Fuzzy Systems Prediction on Training Data

Sr. No.	Fever	Joints Pain	Joint Swelling	Abdominal Pain	Vomiting (Frequency)	Expert's Decision About Proneness to Chikungunya	System's Prediction
1	High	High	High	High	High	Yes	Yes
2	High	High	High	Medium	Medium	Yes	Yes
3	High	Medium	High	Medium	Medium	Yes	Yes
4	Low	High	High	Low	Medium	Yes	Yes
5	Low	Low	High	Medium	Low	Yes	Yes
6	Medium	High	Medium	Low	High	Yes	Yes
7	High	Low	Medium	High	Low	Yes	Yes
8	Medium	High	High	Low	Low	Yes	Yes
9	Low	Medium	Low	Low	Low	No	No
10	Low	Low	Low	Medium	Medium	No	No
11	Medium	Medium	Medium	High	High	No	No
12	Low	Low	Low	Low	Low	No	No
13	High	High	High	Low	Low	Yes	Yes
14	Very High	High	Low	Low	Low	Yes	Yes
15	Very High	Low	Low	Very High	Medium	Yes	Yes
16	Very High	Very High	High	High	High	Yes	Yes
17	High	Very High	Very High	Low	Medium	Yes	Yes
18	Very High	Very High	Low	Low	Low	No	No
19	Very High	Low	Low	Low	Very High	No	No
20	Medium	High	High	Low	Low	Yes	Yes
21	Very High	Very High	High	Low	Low	Yes	Yes
22	High	Low	Low	Low	Medium	No	No
23	Low	Very High	Low	Medium	Medium	No	No
24	Very High	Low	Very High	Low	Low	Yes	Yes
25	High	Low	Low	High	High	No	No

6.1 Prediction Accuracy

A closer observation to other test data score also confirms that the result predicted by the intelligent system, is aligned with the decision that could have been predicted by the expert. However, the biggest benefit is that the system predicts the decision independently without any dependence on the human expert.

Figure 7 represents prediction accuracy of test cases by comparing prediction of classes of training data set and systems generated outcome on test data sets. The system is tested for 25 cases. As observed the system has provided matching of outcome with training data set for 88% of cases while for 12% of test cases systems' could not provide proper results.

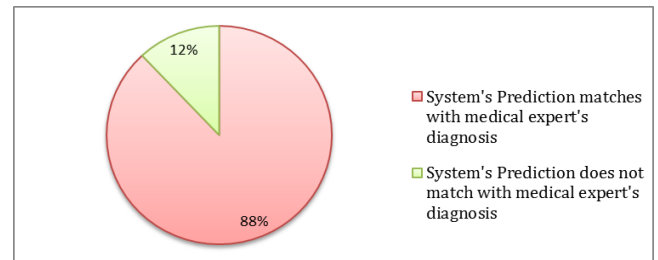


Figure 7: Prediction Accuracy

The significant advantage of the current research work is that, it facilitates development of tool that self-satisfies the need of human expert by automatically taking decisions for intermediate tasks.

7. Conclusion and Future Work

The paper has presented discussion on Genetic-Fuzzy hybrid system. Working characteristics and benefits of genetic algorithm are presented. The detailed discussion on theory of Genetic Algorithm, its advantages and limitations are narrated. The theory of Fuzzy Logic has been explained along with its advantages and limitations. The need of hybridization of Genetic Algorithm with Fuzzy Logic is presented. This hybrid approach leads to development of intelligent procedure to provide decision for diagnosis of types of fever. The paper has presented significant work in order to diagnose disease of Chikungunya at primary stage. The main aim to select the application area for diagnosis of Chikungunya disease is that, due to similar kind of initial symptoms at patient's initial stage, sometimes it is not possible even by medical expert to diagnose the exact type of fever without laboratory tests in its initial stage. But the severities of various symptoms are different such as Very High, High, Low or Medium. The paper has identified linguistic knowledge representation of various symptoms responsible for Chikungunya and other types of fever. Diagnostic rules have been generated in the design of system by interviewing medical experts. The Genetic-Fuzzy system is trained with expert's knowledge. The main advantage of the designed system is that it provides decision regarding type of fever i.e. patient is suffering from fever of Chikungunya or any other. This type of diagnostic system is helpful for initial level diagnosis and hence it is easy to identify the exact disease as many times it happens that several symptoms are common in different diseases. The prediction accuracy of designed intelligent system is explained with clearly defined results.

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