CHAPTER 3

So Compu ng Techniques in Medical Diagnosis

3.1. Introduc on

In recent years disease diagnosis has become a complicated process as the number of diseases and the symptoms of each disease are increasing rapidly. It requires experienced domain experts for proper identification of diseases. Delayed and improper diagnosis is dangerous to human life.

As the burden of patients with various symptoms and diseases to doctors are increasing regularly, the medical professionals have to process tones of data to diagnose diseases properly. Some of these data may be unrelated, uncertain and ambiguous. Thus the diagnosis process is totally dependent on the ability of the domain experts. Due to this situation computer aided disease diagnosis system may be useful. Moreover acute shortage of doctors and poor health services in remote or rural areas can be compensated with the use of soft computing techniques in disease diagnosis.

Soft computing techniques in medical diagnosis are now becoming popular day by day. Recently, it plays an important role in medical domain, which is easy to use also cost effective. Vague and uncertain data which makes the disease diagnosis process too complicated can be handled by soft computing efficiently. As the volume of data related to diseases and their complexities are increasing regularly, diagnosis of diseases become more complicated for health service providers. For this reason this field of medical science can be merged with soft computing techniques and artificial intelligent system to assist physicians to diagnose different diseases accurately in less time. Computer aided disease diagnosis techniques like soft computing, data mining, and intelligent systems may be useful for disease diagnosis, prognosis, decision making and better treatment planning.

3.2. So Compu ng

Lofti A. Zadeh, Professor, University of California, Berkely, U.S.A., was the first to introduce the term “Soft Computing”. According to Professor Zadeh, soft computing techniques possess the tolerance of imprecision, uncertainty, partial truth [1]. In conventional computing it is very difficult to handle vague or uncertain data precisely. As a result, sometimes a lot of computation time may be required in conventional computing. Soft computing differs from conventional computing in this respect. A bundle of various computing tools constitute soft computing, which can handle uncertainty, imprecision, partially truth and approximation to get the result as golden standard. It basically provides solutions to problems accurately in less time and also in low cost.

Few of various techniques such as Fuzzy Expert System (FES), Genetic Algorithm (GA), Artificial Neural Network (ANN) constitute soft computing, which are found to be useful in diagnosing diseases.

3.2.1. Fuzzy Expert System

Fuzzy logic provides an efficient technique that plays a vital role in uncertain environment. It deals with Linguistic Variables whose values are sentences or words and which take the truth values ranges from 0 to 1. As a result situation of partial truth whose truth value ranges between 0 (completely false) and 1 (completely true) can be handled efficiently by fuzzy logic. As a result this technique is capable of handling vague and incomplete data. In real field fuzzy logic can be implanted in both hardware and software to solve some problems in a way by examining the past and forecasting the future [2].

Fuzzy expert system, an application of fuzzy logic produces exact output from vague or uncertain input. It is capable of processing approximate reasoning and producing an exact solution to a problem. The main features which distinguish fuzzy expert system from other mathematical logic are:

(1) Able to solve problems by analyzing the past

(2) Able to work with heuristic information or knowledge.

(3) Capable of handling vague, uncertain, imprecise, partial true and approximate information.

Thus fuzzy expert system may be used as an effective tool to overcome the problem of shortage of medical professionals and also to assist medical practitioners by diagnosing diseases accurately. Stages in fuzzy logic to diagnose diseases are as follows:

(1) Fuzzify all input variables such as symptoms, data related to laboratory tests into fuzzy membership functions.

(2) Generation of fuzzy rules.

(3) The fuzzy inference engine executes all possible rules in the fuzzy rule base to generate output functions.

(4) Defuzzify the output functions to output or crisp value.

Figure 3.1 gives the architecture of fuzzy expert system.

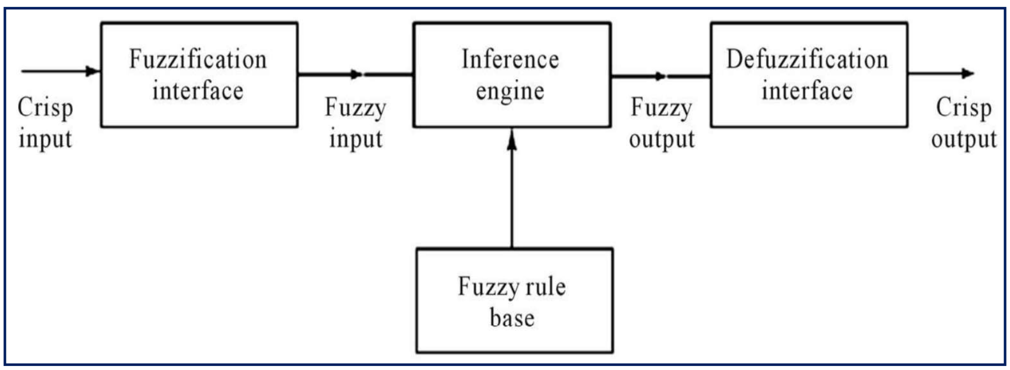


Figure 3.1. Architecture of Fuzzy Expert System

Implementation of fuzzy expert system to diagnose various types of disease has been found in many literatures. In 2000, ECG beats were classified using fuzzy clustering neural network algorithm [3], which produces better result. They used Gustafson Kessel (GK) algorithm to train the network for ECG beat classification. 94% accuracy was achieved to identify heart disease in patient based on Cleveland Foundation data set using fuzzy expert system [4]. Model has been designed using fuzzy logic to generate rules to assist doctors in diagnosing tuberculosis [5]. In 2012, A. V. Senthil Kumar presented a model based on fuzzy resolution mechanism to diagnose heart disease [6]. T. S. Zeki et al. in 2012 proposed a model based on fuzzy expert system implemented in VP – Expert to diagnose type of diabetes disease [7]. In 2013, P. Sharma et al. designed a decision support system using fuzzy logic to diagnose malaria and dengue [8]. In 2013, M. Rana et al. presented a model based on fuzzy logic to diagnose hemorrhage, brain tumor, cardiac disease and thyroid disease [9]. They used Mamdani inference model. An hybrid approach to identify coronary heart disease by combining Genetic algorithm with fuzzy logic was proposed by Y. N. Devi et al. in the year 2014 [10]. In this case Genetic algorithm was used to optimize the membership functions. V. Pabbi proposed a fuzzy inference system with five (5) inputs and one (1) output to diagnose the type of dengue fever in the year 2015 [11]. The proposed system achieved more than 95% accuracy. In 2015, Akinyokun O.C. et al. proposed an expert system bsed on fuzzy logic to identify heart failure disease [12]. Some literatures proposed Neuro-Fuzzy combined approach to obtain better performance. This hybrid approach may perform better as the features of each may remove the demerits of one another to some extent.

Few of the related works implementing fuzzy expert system in diagnosing different diseases, methods used in these works and the results obtained by the proposed models are listed in Table – 3.1.

Table 3.1. Some Works based on Fuzzy Expert System

Disease Diagnosed	Methods Used	Results
ECG beat classification	Fuzzy self organizing neural network trained with Gustafson Kessel (GK) algorithm	Proposed system performed better
Heart disease	Fuzzy Expert System using Mamdani inference model	94% accuracy based on Cleveland database
Tuberculosis	Fuzzy logic	Better performance
Heart Disease	Fuzzy Resolution Mechanism	Proposed system achieved 91.83% accuracy
Diabetes	Fuzzy Expert System implemented in VP – Expert	Better performance of the proposed system
Malaria and Dengue	Fuzzy logic implemented in MAT LAB	Performed better
Hemorrhage, Brain Tumor, Cardiac Disease, Thyroid Disease	Fuzzy Expert System using Mamdani inference method	Proposed system performed better
Coronary Artery Disease	Fuzzy Expert System combined with Genetic Algorithm	88.79% accuracy was achieved
Dengue fever	Fuzzy Expert System implemented in MAT LAB – 7.10	95+% has been achieved by the proposed system.
Heart Failure Disease	Fuzzy Expert System	Accurate result has been achieved based on several decision variables.

3.2.2. Gene c Algorithm

Genetic algorithms are search based optimization algorithms based on natural evolution processes like natural selection and natural genetics [13]. Genetic Algorithms were first introduced by John Holland and his colleagues at the University of Michigan, U.S.A. It is a powerful search technique, used to obtain optimal solutions or solutions closed to optimal solutions for complicated problems, which may take life-time to solve, otherwise. In Genetic Algorithm a subset of all possible solutions, called population analogous to population of human beings, is taken into consideration initially. Population initialization can be done either randomly or heuristically. Each encoded solution in the population is called chromosome. It is an important step to choose proper encoding technique depending on the problem. A fitness value, evaluated from object scoring function or fitness function, is assigned to each solution (or candidate solution), which reflects how good the solution is for the given problem. Solutions with higher fitness values i.e. fitter individuals (parents) are chosen for applying genetic operators – crossover and mutation to generate population for next generation, which yields better solution to the problem. It is analogous to Darwin's theory of "Survival of the fittest". This process of evolution is repeated until the stopping criteria achieved. The stopping criteria may be one of the following:

a) No better solution is evolving

b) Fitness value reached to a predetermined value.

c) Absolute number of generations has been evolved

In recent years the task of diagnosis of diseases in medical science has become one of the complex processes due to large variety of diseases and their symptoms. To do this a large volume of data has to be processed to identify a particular disease. One of the main advantages of Genetic Algorithm is that it performs better in comparison to other approaches for optimization when the search space is large or may be huge. It results in optimal combinations of search. Recently, Genetic Algorithm has been applied in many areas including diagnosis of diseases as it is one of the best optimization approaches. In diagnosing of a particular disease each attribute of interest are coded into binary string (chromosome) to form initial population. A fitness value is assigned to each chromosome. Chromosomes with higher fitness values are chosen for crossover and mutation to form population for next generation, which is more precise with reduced number of attributes. Figure 3.2 represents the steps in Genetic Algorithm.

In some cases it becomes very hard to analyze the important information, which is lying hidden inside the data set used for medical research. In those cases meta-heuristic search algorithm like Genetic Algorithm plays an important role to find optimal or nearly optimal solution in a reasonable time. Thus medical practitioners may be benefited by applying this algorithm to solve medical problems with complicacy. Areas of application of Genetic Algorithm in medical science may include disease screening, diagnosis, treatment planning, pharmacotherapy, prognosis and health care management [14].

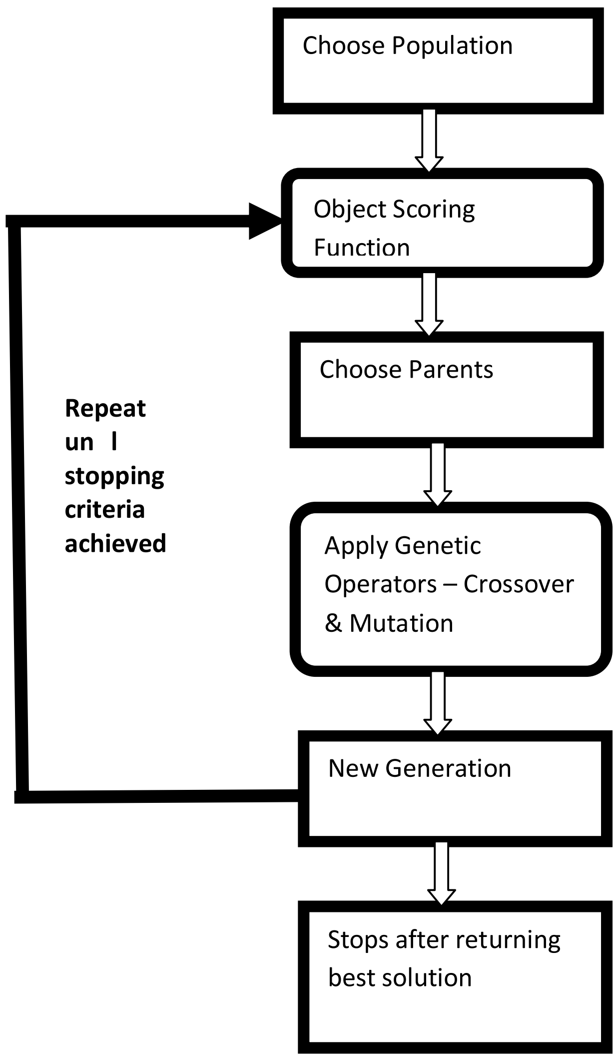


Figure 3.2. Steps in Gene c Algorithm

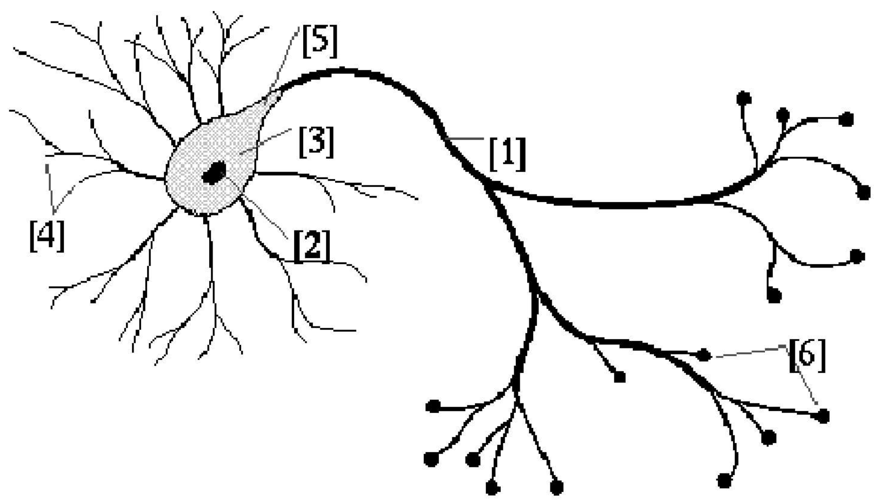
Use of Genetic Algorithm in medical diagnosis has been found in many literatures. E.P. Ephzibah presented a paper in which Genetic Algorithm was used to generate best feature subset based on UCI Diabetes dataset. After extracting features an effective prediction was made using Fuzzy Logic on the dataset with reduced features. This approach of combining Genetic Algorithm with Fuzzy Logic demanded as a cost effective approach and also produced better result as compared to other related works [15]. In a study an hybrid approach of wrapping Genetic Algorithm with Bayes Naïve (BN) classification was suggested to diagnose Coronary Artery Disease (CAD) [16]. The work used CAD dataset containing two classes defined with 13 attributes. In this work Genetic Algorithm was used to determine subset of features in each generation, which has been classified using BN classifier. The most relevant attributes were obtained from the final step, which yielded better result as compared to other methods. F. Tchier et. al focused on Fuzzy relational model in combination with Genetic Algorithm for early diagnosis of breast cancer to reduce high cost of treatments of breast cancer. This work used Saudi breast cancer diagnosis database. The proposed model exhibited high classification accuracy based on few simple rules [17]. In a study Parkinson’s disease has been diagnosed based on speech analysis using Genetic Algorithm and Support Vector Machine (SVM) in combination. In this study Genetic Algorithm was used to select optimized features from all extracted features and SVM was used for classification. The results showed that an accuracy of 94.5% was achieved with extracting four optimized features [18]. D. Dhanwani et. al presented a hybrid model by integrating Genetic Algorithm and Back Propagation Algorithm to predict stroke disease. In this study Genetic Algorithm was used to improve the performance of Back Propagation Algorithm. From this work it is evident that GA-NN approach yielded better average prediction accuracy as compared to the traditional Artificial Neural Network (ANN) [19]. P. Johnson et. al showed the potential of Genetic Algorithm by generating a small set of attributes rather than all the single significant features to predict the progression of Alzheimer’s disease using a prediction model based on Logistic Regression. In this paper Genetic Algorithm was used to select one or more sets of neuropsychological features that can predict the progression of Alzheimer’s disease with high accuracy and Logistic Regression was used to develop predictive model [20]. B. Kaur et. al aimed to design a model based on Genetic Algorithm to predict heart disease. An accuracy of 73.46% was achieved by their suggested predictive model [21]. A Genetic Algorithm based fuzzy logic was suggested in a study for computer aided diagnosis scheme in medical imaging. The proposed scheme was implemented to differentiate myocardial heart disease from images of Echo Cardio Graph (ECG) and also to detect and classify clustered micro-calcifications from mammograms. The result they obtained may claim a good performance of the proposed system [22]. An automated system has been proposed to diagnose hepatitis disease, one of the major problems world-wide, based on Genetic Algorithm in combination with Wavelet Kernel (WK) Extreme Learning Machine (ELM), which is a single layer neural network. In this study three adjustable parameters and the number of hidden neurons were tuned by using Genetic Algorithm. Experiments were made on UCI hepatitis disease dataset. The classification accuracy of the proposed GA-WK-ELM method was obtained as 92.7273% [23]. A study attempted to design an intelligent system based on Genetic-Fuzzy hybrid system to diagnose Chikungunya at an early stage. The proposed model attempted to identify Chikungunya based on complaints from patients (symptoms) before doing any laboratory test. It has been suggested that this type of automated system is very much useful for medical diagnosis at initial level as it provides decision by correctly predicting the type of fever i.e. whether the patient is suffering from Chikungunya or not [24]. Table3.2. presents a list of studies where Genetic Algorithm performed better in diagnosing diseases.

Table 3.2. List of Studies where Genetic Algorithm Performed Be er

Disease Diagnosed	Methods Used	Results
Diabetes	Genetic Algorithm in combination with Fuzzy Logic	87% accuracy
Coronary Artery Disease	Genetic Algorithm in combination with BN classifier	85.5% accuracy
Breast Cancer	Fuzzy relational model in combination with Genetic Algorithm	96.67% accuracy based on 4 rules
Parkinson’s disease	Genetic Algorithm in combination with Support Vector Machine	94.50% accuracy for 4 optimized features
Stroke disease	Back Propagation Network in combination with Genetic Algorithm	98.67% accuracy
Alzheimer’s disease	Genetic Algorithm in combination with Logistic Regression	Performed better
Heart disease	Genetic Algorithm	73.46%
Heart disease	Genetic Algorithm in combination with Fuzzy Logic	88.5% accuracy
Hepatitis	Genetic Algorithm in combination with Wavelet Kernel Extreme Learning Machine	92.7273% accuracy
Chikungunya	Genetic Algorithm in combination with Fuzzy Logic	88% accuracy

3.2.3. Ar cial Neural Network

Motivated by the improvement of neurobiological science, researchers attempted to develop model of neurons of human brain to solve complex mathematical problems like image processing, pattern recognition etc. by simulating neural behavior. The fundamental structural and functional unit of human brain is neuron, which helps in the unidirectional flow of impulse, received from other neurons through links, called dendrites. Figure 3.3 depicts biological neuron.



1.Axon 2. Nucleus 3.Soma (Body) 4. Dendrite 5. Axon Hillock 6. Terminals (Synapses)

Figure 3.3. Biological Neuron

The main three components of neuron are : dendrites, soma and axon. The dendrites are branched extension of soma. Its branching helps it to collect the impulse from end plate of axon of other neuron. Soma transmits impulse from dendrites to the axon. Axon helps to transmit impulse to other neurons. Synapse is the region of junction between two neurons that helps in impulse conduction. The incoming signals are summed up in soma and the cell fires when the sum reaches a threshold value.

Artificial Neural Network (ANN) mimics the workings of biological neuron of human brain. The neurons are connected to one another by connection links. Each of these links has a weight. In the year 1943, Mc Culloch and Pitts were the first to introduce mathematical model of neuron as shown in Figure 3.4 [25]. This model of neuron is the basis of the discipline of ANN. Each input line is associated with a weight, which is normalized in the range (0,1) or (-1,1). The summing part produces weighted sum. The activation function f produces only a binary output depending on the threshold value. In the literatures different forms of ANN are there for performing different tasks. Depending upon the functions to be performed different neural network models assume different architectures and modes of operation for the network.

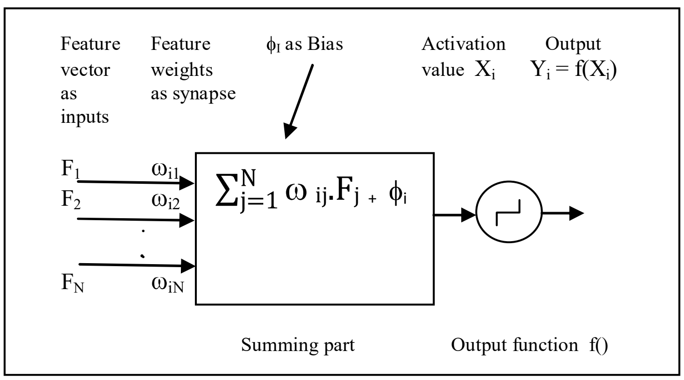


Figure 3.4. McCulloch-Pitts Model of a Neuron

Modeling with ANN involves two important tasks, namely, design and training or learning the network. The design phase of a network involves – (1) fixing the number of layers (2) fixing the number of neurons for each layer (3) the node function for each neuron (4) the connectivity patterns between the layers and the neurons (5) the type of network, whether feedback or feed-forward.

In neural network neurons are organized in different layers. All the neurons of the same layer possess same behavior. Input layer, hidden layer and output layer are the names of different layers in neural network architecture. The neurons in the input layer are passive and simply transmit the input signal to the neurons in other layer. The layer, which is in between the input and output layer is known as hidden layer. The neurons in the hidden and output layers are active and modify the signal as received through a link depending on the weight applied to the link. Depending on the architecture there are two kinds of neural network, namely, single layer network and multi layer network.

Figure 3.5(a) represents a single layer neural network. It is the simplest kind of network with neurons arranged in two layers – input layer and output layer. It is referred to as single layer because only the neurons of output layer perform computation depending on the input transmitted by the neurons in the input layer and weight of the links connected to the neurons. This type of network is useful for solving pattern classification problems.

Figure 3.5(b) represents a multilayer neural network. In multi layer neural network there is at least three layers. Hidden layers are employed in between input layer and output layer. Neurons in hidden and output layers are able to perform computation. Any type of problem can be solved by this kind of network with nonlinear activation function.

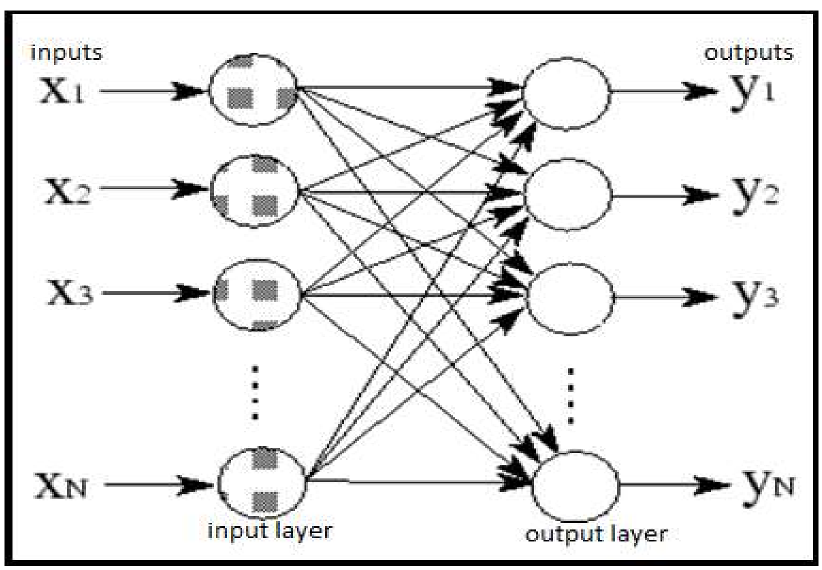


Figure 3.5(a). Single Layer Network

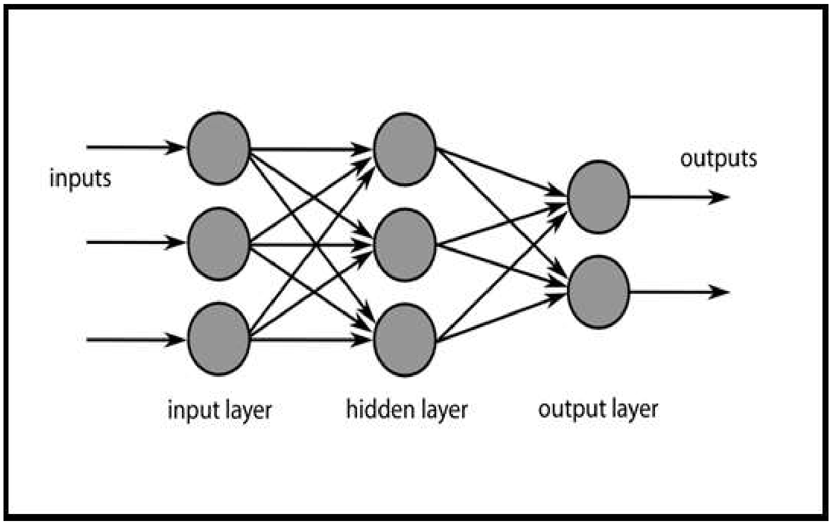


Figure 3.5(b). Mul   Layer Network

3.2.3.1. Ac va on Func on

Generally, the activation function for each of all the neurons of the same layer is same. Different types of activation function are taken into consideration. Some of them are discussed below pictorially.

- **Linear Func on**

  It is also known as identity function and is of the form :

  f(x) = x for all x.

  It is depicted in Figure 3.6(a).

- **Binary Step Func on**

  Binary step function or simply step function is defined as follows :

  f(x) = 1, where x ≥ Ө, where Ө is the threshold value.
  = 0, otherwise.
  It is depicted in Figure 3.6(b).

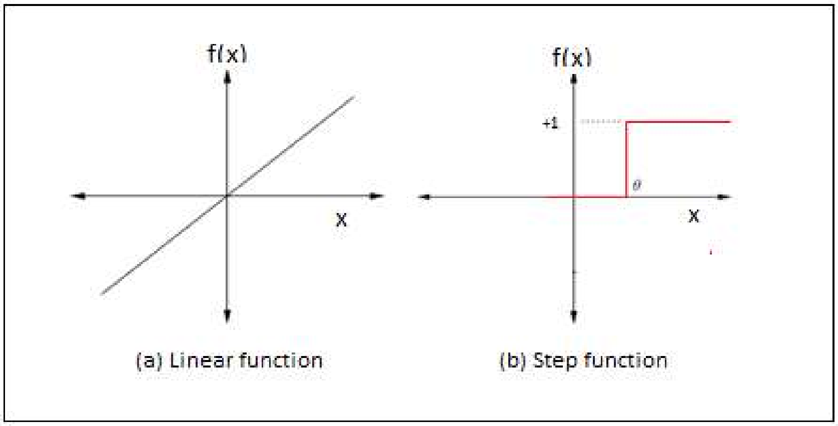


Figure 3.6. Graphical Presenta on of Linear Func on and Step Func on

- **Bipolar Sigmoid Func on**

Bipolar sigmoid function produces an output whose value ranges in between -1 and +1 and which is of the form:

$$f(x) = \frac{2}{1 + e^{-x}} - 1$$

It is presented graphically in Figure 3.6(c).

- **Sigmoid Func on**

Sigmoid or logistic function is monotonous and also bounded. For this reason this function has been widely used as an activation function. This function is of the form:

$$f(x) = \frac{1}{1 + e^{-x}}$$

It is presented graphically in Figure 3.6(d).

- **Hyperbolic Tangent func on**

Hyperbolic tangent function is of the form :

$$f(x) = \tanh(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$$

The graphical presentation is shown in Figure 3.6(e).

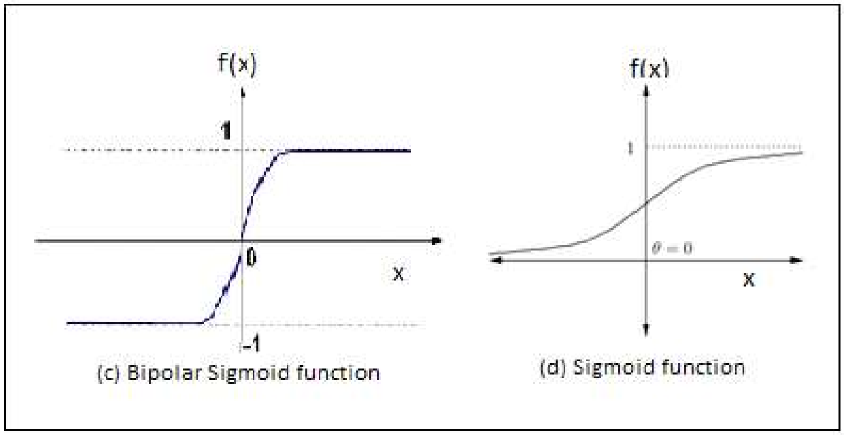


Figure 3.6. Graphical Presenta on of Bipolar Sigmoid and Sigmoid Func ons

- **Gaussian Func on**

  Gaussian function is of the form :

  $$f(x) = \mathrm{aExp}(\frac{-(x-b)^2}{2\mathrm{c}^2})$$

  Where a, b, and c are arbitrary real constants. The value of ‘a’ determines the peak of the curve, ‘b’ denotes the position of center of the peak and the width of the curve depends on the parameter ‘c’. Graphical presentation of the Gaussian function is presented in Figure 3.6(f).

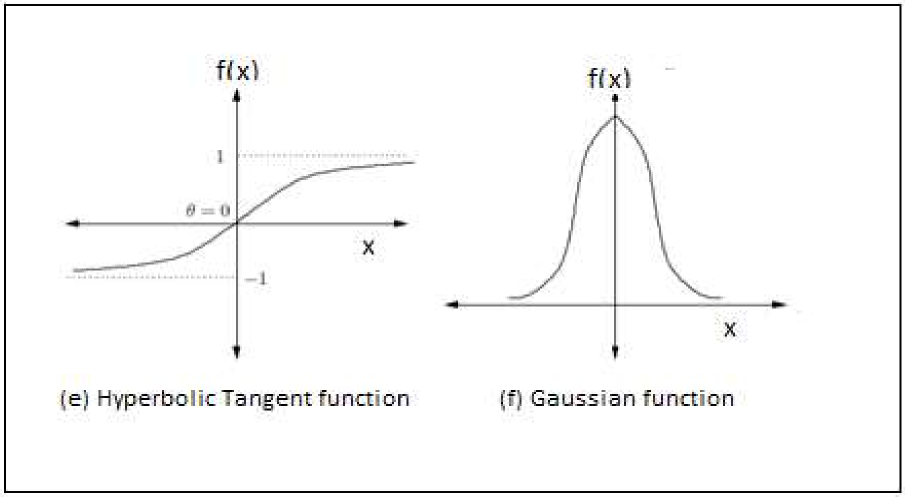


Figure 3.6. Graphical Presenta on of Hyperbolic and Gaussian Func ons

3.2.3.2. Types of Architecture of Neural Network

Depending on the direction of flow of information through nodes of different layers of the network there are mainly two kinds of neural network, namely feed-forward neural network and feedback neural network.

Feed-forward neural network is a learning model, designed to compute some functions approximately. It is termed as feed-forward as information flows through nodes of different layers from input to the output in the same direction i.e. no feedback of information is allowed in this kind of network.

Presence of loops in the architecture of feedback neural network allows information to flow in both directions. The output of a node of any layer depends on the input to the node and also on the output of that node. As a result the states of this kind of networks are changing dynamically until an equilibrium condition has been reached.

3.2.3.3. Training or Learning Algorithms

One of the most important properties of artificial neural network is its capability of learning. This learning phase involves adjustments of different parameters such as link weights, threshold values etc. to produce a desired response. Learning algorithms are categorized as follows:

1. Supervised learning
2. Unsupervised learning

Supervised learning algorithm uses training dataset, which consists of an input vector and a target vector. During training phase the input vector is applied to the input of the network and an output vector is generated. By comparing this output vector with the target vector an error signal is generated if the output vector differs from the target vector. This error signal is used to readjust the link weights of the network and threshold value to produce correct response. Thus supervisor or teacher plays a role in this kind of learning mechanism to minimize error.

Unsupervised learning algorithm is used in the cases where only an input vector is available. There is no output vector and there is no supervisor or teacher. Similar types of input vectors are grouped into categories to learn about the data and to discover important pattern in the data. Following are examples of unsupervised learning algorithms:

1. K-means (to solve problems related to clustering)
2. Apriori (to find out association rules)

In supervised learning, the training phase or learning phase involves adjustments of weights as well as threshold values from a set of training examples. This kind of learning law was first proposed by Donald Hebb [26]. At present, there are hundreds of such learning algorithms are available in the literature [27], but the most well-known among them are back-propagation [28], [29], ART [30], and RBF networks [31]. This work concentrated on Incremental Back-propagation Learning Network (IBPLN) algorithm and on Levenberg-Marquardt (LM) algorithm.

3.2.3.4. Incremental Backpropaga on Learning Network (IBPLN)

The normal back-propagation network is not an incremental by its nature [32]. The network learns by the back-propagation rule of Rumelhart et al. [33] under the constraint that the change to each weight for each instance is bounded. With this learning rule, it is likely that adjustments of different weights may be truncated at different proportions. As a result, the network weight vector may not move in the steepest descent during error minimization. In IBPLN, this problem is dealt with by introducing a scaling factor s which scales down all weight adjustments so that all of them are within bounds. The learning rule is now:

$$\Delta W_{ij}(k) = s(k)\,\eta\delta_j(k)O_i(k) \qquad (1)$$

where W_{ij} is the weight from unit i to unit j, η ($0<\eta<1$) is a trial independent learning rate, δ_j is the error gradient at unit j, O_i is the activation level at unit i, and the parameter k denotes the k-th iteration. In the incremental learning scheme, initial weights prior to learning any new instance, represent knowledge accumulated so far. IBPLN introduced two structural adaptations; neuron generation and neuron elimination. The IBPLN algorithm proceeds as follows [32] :

Given a single misclassified instance :

Begin
    Repeatedly apply the bounded weight adaptation learning rule (3) on the instance until stopping criteria are met.
If
    the instance can be correctly learned, then restore the old weights and apply the bounded weight adaptation learning rule once;
Else
    restore the old weights and apply the structural adaptation learning rules.
End.

The stopping criteria are: The instance can be correctly learned or the output error fluctuates in small range.

3.2.3.5. Levenberg-Marquardt (LM) Algorithm

The Levenberg-Marquardt (LM) algorithm is basically an iterative method that locates the minimum of a multivariate function that is expressed as the sum of squares of non-linear real-valued functions [34], [35]. LM algorithm can be thought of as a combination of steepest descent and the Gauss-Newton (GN) method. LM algorithm is more robust than GN algorithm which essentially means that it finds a solution even if it starts far off the final minimum. During the iterations, the new configuration of weights in step (k+1) is calculated as follows:

$$w(k+1) = w(k) - (J^T J + \lambda I)^{-1} J^T \varepsilon(k) \qquad (2)$$

where J – the Jacobian matrix, λ - adjustable parameter, ε - error vector. The parameter λ is modified based on the development of error function. If the step causes a reduction of error function, we accept it. Otherwise λ is changed; reset the original value and recalculate w(k+1).

Thus the LM algorithm is as follows:

1. Update the value of λ based on the rule as given in equation (2).
2. Evaluate the error function.
3. If no improvement in error is obtained modify λ and reset the weights to their original values. Go to step 1 to try an update again.
4. If the error is reduced, accept the new values of weights and modify λ.

3.2.3.6. Implementa on of Ar cial Neural Network

Due to some important characteristics of artificial neural network like fault tolerance, generality, self learning capability, and ability to solve complex problems, it has now been applied to various fields and also has been used as tool to diagnose different diseases. Many literatures have been found in which ANN has been implemented to diagnose different diseases. A comparative study was performed to diagnose Tuberculosis disease using ANN in the year 2008 [36]. The proposed model used multi layer neural network (MLNN) and general regression neural network (GRNN). It was concluded that MLNN structure with two hidden layers trained by

Levenberg-Marquardt algorithm produced better classification accuracy of 95.08%. Q. Kadhim et. al proposed an intelligent model based on ANN to diagnose urinary system diseases [37]. The dataset from UCI machine learning repository was used in this literature. Feed-forward back propagation neural network algorithm was proposed to train the network and an accuracy of 99% was claimed. A neural network approach to analyze heart disease has been presented in a study in the year 2011 [38]. From this study it is evident that a multilayer neural network trained with back-propagation learning algorithm performed better and accuracy of 94% was achieved as the performance of the network. Y. Unal et. al [39] proposed a wavelet based ANN to classify intervertebral degenerative disc disease. The reason of the disease is the reduction of fluid that acts as shock absorber. Expertise is needed to correctly diagnose the disease; otherwise there is a possibility of wrong diagnosis. Features were extracted from MRI using wavelet transform and the extracted features were used as an input to MLP to classify the disease. The proposed model has been suggested as the supporting tool for radiologist in diagnosing the disease and can be improved in future. In a study authors attempted to design an automated system using two types of artificial neural networks to classify Parkinson's disease [40]. They used multi layer perceptron (MLP) with Levenberg-Marquardt (LM) back-propagation algorithm and radial basis function (RBF) network. Parkinson's disease dataset from UCI machine learning repository was used in this study. It was observed that MLP with back-propagation learning algorithm performed better in comparison to RBF network. In the year 2012, K. Kumar et. al presented a paper [41], in which they proposed different intelligent models based on ANN to diagnose kidney stones disease. They compared three different neural networks of different architecture and characteristics. They used MLP with back-propagation learning algorithm, learning vector quantization (LVQ) and radial basis function (RBF) network to diagnose the disease. It was found that among the three approaches, the model based on MLP with back-propagation algorithm performed better and an accuracy of 92% was achieved. F. S. Gharehchopogh et. al considered a multi layer perceptron

ANN using back-propagation learning algorithm to diagnose thyroid disease [42]. The proposed network consists of one input layer with 5 neurons, one hidden layer with 6 neurons and an output layer with only one neuron. An accuracy level of 98.6% was claimed in the literature. In reference to [43] authors suggested a model to diagnose diabetes disease using ANN. In this study, database of Pima Indian diabetes has been taken into consideration. Multilayered feed-forward network trained with back-propagation algorithm yielded correct classification accuracy of 82%. An automated system to classify important chest diseases, like chronic obstructive pulmonary, pneumonia, asthma, tuberculosis and lung cancer, was proposed by authors in 2016 [44]. They implemented different neural network models to classify the chest diseases. It was claimed in the study that probabilistic neural network (PNN) structure performed better in diagnosing chest diseases. Sujatha. K et. al presented a model in the year 2017 for early detection of Alzheimer disease using ANN [45]. Alzheimer's disease is a neuro-degenerative disorder in which brain cells are affected. Common symptoms of this disease are: loss of memory, personality change, losing the capability of thinking. Generally, aged people are suffering from this disease. The suggested model used discrete wavelet transform (DWT) to extract important features from brain image. Back propagation neural network (BPNN) was used to classify the disease. PSO algorithm was also used to tune the network. An accuracy of 96.32% was achieved as found in the study. Many more literatures have been found in which ANN has been used as a tool in the field of medical diagnosis. A brief study of literatures in which ANN performed better are listed in Table 3.3.

Table 3.3. List of Studies where Ar cial Neural Network Performed Be er

Disease Diagnosed	Methods Used	Results
Tuberculosis Disease	MLNN with Levenberg-Marquardt Algorithm	95.08% accuracy
Urinary System Diseases	Feed-forward Back-propagation Network	99% accuracy
Heart Disease	Multilayer neural network + Back-propagation learning algorithm	94% accuracy
Intervertebral Degenerative Disc Disease	MRI + MLP	100% classification rate and training performance was 99.79%.
Parkinson's Disease	MLP + LM	93.22 % accuracy
Kidney Stones Disease	MLP + Back-propagation algorithm	92% accuracy
Thyroid Disease	MLP using Back-propagation learning algorithm	98.6% accuracy
Diabetes Disease	Multilayered feed-forward network + Back-propagation learning algorithm	82% accuracy
Chest Disease	PNN	92.16% as an average accuracy
Alzheimer Disease	BPNN in combination with DWT and PSO	96.32% accuracy

3.3. Conclusion

We discussed various approaches of soft computing methods, designed by researchers in the domain of medical science. Researchers attempted to develop decision support systems, new algorithms and tools to diagnose different diseases efficiently. Soft computing, an area of artificial intelligence, is an emerging tool or collection of techniques used to develop intelligent predictive models for the purpose of diagnosing different diseases. However the selection of proper methodology depends on the type of the dataset. The hybrid system, which is the combinations of soft computing methodologies i.e. the combination of Neural Network with Genetic Algorithm (NN + GA), Neural Network with Fuzzy Logic (NN + FL) and Fuzzy Logic with Genetic Algorithm (FL + GA), used to build intelligent automated systems with better performance. In hybrid system limitation of one paradigm may be removed by the merits of the other. The objective is to design a model such that the accuracy of the system should be comparable with domain expert, otherwise wrong predictions may harm the patient. For this reason care should be taken on the lowest performance of the system. Vigorously a system is needed to reduce false prediction rate as well as to help in early diagnosis of diseases. A lot of work has already been done in the field of medical science to justify the usefulness of soft computing techniques and obviously, a lot to be done in future.

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