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Generalized Anxiety Disorder : Prediction using ANN

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Abstract— **Artificial Neural Network plays an important role in medical diagnostics field and used by medical practitioners and domain specialists for diagnosis and treatment with ultimate accuracy. In this paper, a medical diagnosis system is proposed for predicting Generalized Anxiety Disorder (GAD). In today's world of computational Intelligence, Swarm Intelligence technique is one of the successive ways to solve hard medical problems. Particle Swarm Optimization (PSO) imitates the behavior of a swarm of insects or a group of fish or birds. In this paper the relative advantages of genetic algorithm, Particle Swarm Optimization and Artificial Neural Network (ANN) are combined to achieve the desired accuracy. ANN's are often used as a powerful discriminating classifier for tasks in medical diagnosis for early detection of diseases. The data set on this study is composed of 200 patients with various sign symptoms. The objective of this paper is to determine the weights of the neural network using genetic algorithm in less number of iterations and PSO algorithm for feature Reduction. For training the network Quasi-newtonalgorithm is used in this study using various training algorithm parameters. The accuracy obtained using this approach is 98.56%.**

Keyword-*Artificial Neural Network (ANN); Genetic Algorithm (GA); Particle Swarm Optimization (PSO); Generalized Anxiety Disorder (GAD)*

I. INTRODUCTION

Generally people worries about the relationships between themselves, deadlines for any particular job assigned to them, present on time to an appointment and many others examples of being wordiness. But people suffering with Generalized Anxiety Disorder, or GAD, experiences excessive, persistently, and unrealistic worriedness on a regular basis. They feel that the said problems may beyond their control [1]. They are very anxious about the worriedness and try to get rid of it during every time. Suffered people think, things will always go poorly. At times, worriedness makes people mentally disturbed from everyday tasks. GAD develops slowly. It often starts during the ten years or young adulthood. Symptoms may get better or worse at different times, and often are worse during times of stresses. People with GAD often expect the worst, even when there is no reason for any concern.

If their worriedness continues more than six months they often suffers mentally, physically, financially, and even that may affect their family and service place as well. The exaggerated, unrelenting worrying interferes with everyday living. Physical symptoms often accompany it and include restlessness, irritability, muscle tension, fatigue, and difficulty sleeping or less concentration.

Researchers have found that several parts of the brain are involved in fear and anxiety. By learning more about fear and anxiety in the brain, scientists may be able to create better treatments. Researchers are also looking for ways in which stress and environmental factors may plays vital role in this context [2].
Generalized anxiety disorder can affect all areas of life, including social, work, school and family. According to a national survey conducted by the Anxiety Disorders Association of America, 7 out of 10 people with GAD agreed that their chronic

anxiety had an impact on their relations with spouses or significant others and two-thirds reported that GAD had a negative effect on their friendships.

It is absolutely essential to identify and select the correct symptoms of GAD, So that correct diagnosis of GAD can be done efficiently. In the advent of computational intelligence this becomes easy and more accurate. Artificial Intelligence is a very popular technique in medical science for predicting disease during last few years. Combining neural networks with particle swarm optimization, genetic algorithm are one of the approaches researchers use. It reduces various medical errors and better prediction of diseases.

Recent world of computational intelligence neural networking techniques has been found one of the most efficient and vastly used techniques for predicting the diseases. The neural networks can be related with non-linear statistical data modeling tools. Even they are used to build complex relationships between inputs and outputs and/or to find patterns in data [3].

In artificial neural networks, network learning algorithms train the network slowly. Avoiding slow learning problem, researchers often use optimization methods like particle swarm optimization (PSO), genetic algorithm (GA), Ant Colony Optimization (ACO) techniques to find the networks weights.GA may be useful for searching and selecting features if there is huge search space. On the other hand, Swarm Intelligence leads to more optimal system for complex problem. It has been used to give an optimal set of connections or weights for each of the individual experts involved. Back propagation neural network determines the hidden layers parameters and numbers of hidden nodes in the networks.

The objective of this paper is to develop an intelligent system using PSO, GA algorithm to analyze the large amount of data and optimum diagnosing criteria. Then criteria's are applied to predict the disease.
The remainder of the paper is organized as follows:

In section II we discuss the related studies of GA, PSO with ANN. In section III, we explain the objectives of feature selection algorithms. A brief detail of PSO and GA have been discussed. Section IV discusses the neural networking. In section V presents the implementation logic using GA algorithms. Section VI elaborates the ANN architecture development and section VII explains discussion after optimization and the result. Experimental results are followed by a short concluding Section in VIII, where we outline the directions of the trends.

II. RELATED STUDIES

There are several research works which have applied neural networks with PSO and/or GA in the diagnosis of different disease. In a study, artificial neural networks with PSO and GA are used for predicting neonatal disease diagnosis. The proposed technique involves training a Multi-Layer Perceptron with a Levenberg-Marquardt learning algorithm to recognize a pattern for the Diagnosing and PSO and GA is used to find the best featured attributes. Hence, in this study prediction of neonatal diseases reflects better accuracy [4].

In another paper, a medical diagnosis system is presented for predicting the risk of heart disease. In this paper the relative advantages of genetic algorithm and neural network are combined to achieve the desired accuracy. Feed-forward and fitting neural networks are used for the suited complex problems. The accuracy obtained using this approach is 97.75%[5].

This paper is also presented for predicting of heart disease but with PSO algorithms. The paper proposes Particle Swarm Optimization (PSO) algorithm for Feature Reduction. Artificial Neural Network is used for classifying the patient as diseased and non- diseased. The network is trained under two conditions like before applying PSO and after applying PSO on training data[6].

III. FEATURE SELECTION

In GAD disease diagnosis field the vital challenges which remain unsolved are the small sample size problem domains. Feature selection and extraction, which are based on a limited training set,displays poor generalization performance on new datasets. To mitigate this problem, PSO and GA have been proposed for attributes features selection which has to be used for predicting GAD disease diagnosis.

A. Genetic Algorithm(GA)

Basic ideas on Genetic algorithms were first developed by John Holland, and are mainly used as search and optimization methods. Given a large solution space, one would like to pick out the point which optimizes an object function while still fulfilling a set of constraints. In network planning, a solution point could be a specific link topology, a routing path structure, or a detailed capacity assignment with minimum costs [7].

GA is basically inspired by Darwin's theory of evolution-survival of the fittest [8]. Genetic algorithms are based on the idea of natural selection. In nature, the properties of an organism are determined by its genes. Starting from a random first generation with all kinds of possible gene structures, natural selection suggests that over the time, individuals with "good" genes survive whereas "bad" ones are rejected. Genetic algorithms try to copy this principle by coding the possible solution alternatives of a problem as a genetic string. The genes can be bits, integers, or any other type from which a specific solution can be deduced. It is required that all solution points can be represented by at least one string. On the other hand, a specific gene string leads to exactly one solution. A set of a constant number of gene strings, each characterizing one individual, is called a generation.

Since the different strings have to be evaluated and compared to each other, the notion of fitness is introduced. The fitness value correlates to the quality of a particular solution. Instead of working with the actual solution itself, genetic algorithms operate on the respective string representation. The following three basic operators are applied [9]:

(i) Reproduction

(ii)Crossover

(iii) Mutation

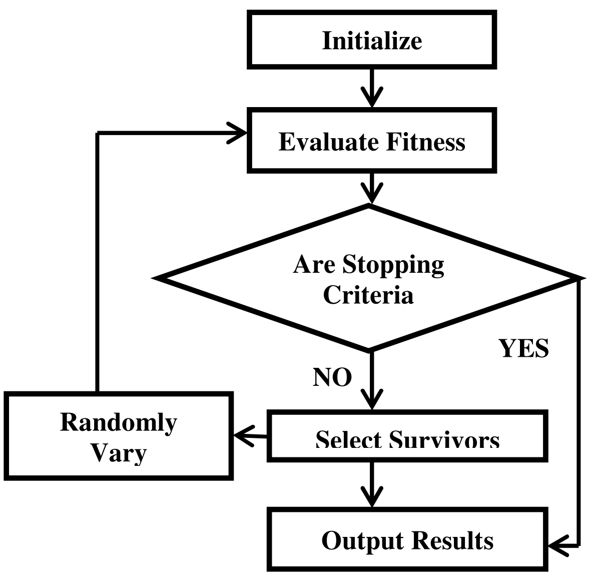

Figure1.Genetic Algorithm Process

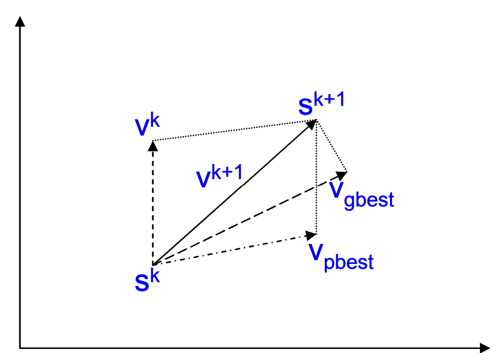

Figure 2. Searching Point Modification

B. Particle Swarm Optimization(PSO)[10]

Particle Swarm Optimization (PSO) is a conventional and semi-robotic algorithm [11].PSO [12] is an evolutionary computational algorithm inspired on a natural system. It is developed in 1995 by James Kennedy and Russell Eberhart based on the social behaviors of birds flocking or fish schooling from the natural system.

PSO is initialized with a group of random particles or solutions and then searches for optima by updating generations, the particles are "flown" through the problem space by following the current optimum particles. Each particle keeps track of its coordinates in the problem space, which are associated with the best solution(fitness) that it has achieved so far. On a given

iteration, a set of solutions called “particles” move around the search space from one iteration to another accordingly to rules that depend on three factors:
1) *Inertia:* Here the particles tend to move in the direction
2) *Memory*: It is the particles which tend to move in the direction of the best solution found so far in their trajectory.
3) *Cooperation:* The particles tend to move in the direction of the global best solution.

The idea behind PSO is in speeding up each particle toward its pbest and gbest locations, with random weights acceleration at each time step. The meaning of these two locations are given below:

- *Pbest(Personal best)*: Every particle remain maintain the track of its coordinates in the solution, i.e. fitness, although particles are far away from the target.
- *Gbest(Global best):* There is another best value that is tracked by the PSO is the best value obtained so far by any particle in the neighborhood of that particle.
  The concept of modification of a searching point by PSO is illustrated in figure 2.

Where,
s^k: current searching point.
s^{k+1}: modified searching point.
v^k: current velocity.
v^{k+1}: modified velocity.
v_{pbest} : velocity based on pbest.
v_{gbest} : velocity based on gbest
Each particle tries to modify its position using the following information: the current positions, the current velocities, the distance between the current position and pbest, the distance between the current position and the gbest.

The modification of the particle’s position can be mathematically modeled according the following equation :

$$V_i^{k+1}=wV_i^k+c_1rand_1(.)x(pbest_i-s_i^k)+c_2rand_2(.)x(gbest-s_i^k) \quad (1)$$

where, v_i^k : velocity of agent i at iteration k,
w: weighting function,
c_j : weighting factor,
rand : uniformly distributed random number between 0 and 1,
s_i^k : current position of agent i at iteration k,
$pbest_i$:pbest of agent i,
gbest: gbest of the group.

Hence the weighting function is:

$$w = wMax-[(wMax-wMin) \text{ x } iter]/maxIter \quad (2)$$

Where, wMax= initial weight,
wMin = final weight,
maxIter = maximum iteration number,
iter = current iteration number.

$$s_i^{k+1} = s_i^k + V_i^{k+1} \quad (3)$$

The PSO algorithm involves just three steps, which are being replicated until stopping condition; they are as follows [10]:
(i) Evaluate the fitness of each particle.
(ii) Update pbest and gbestfunctions.
(iii) Update velocity and position of each particle.

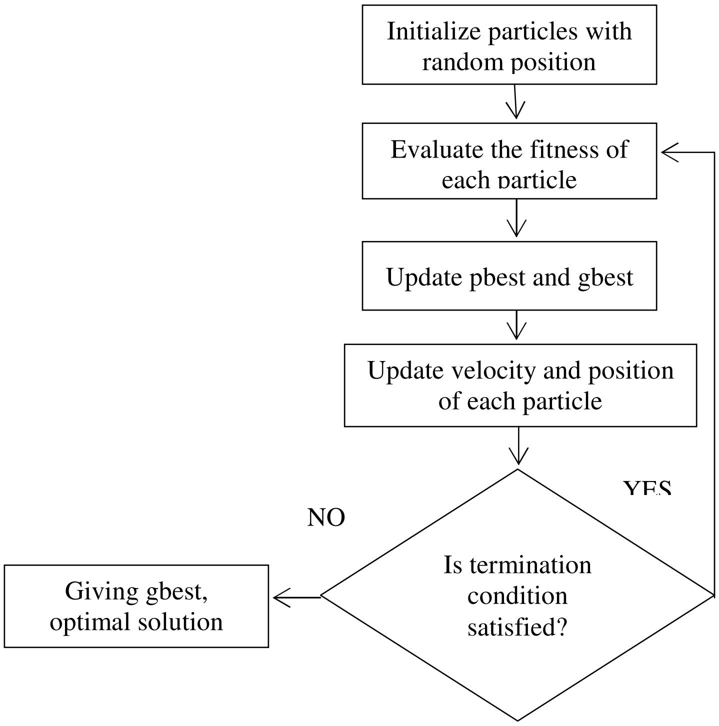

Figure 3.PSO Algorithm Process

IV. ARTIFICIAL NEURAL NETWORK[13]

In neural networks there are various processing elements called nodes, actually take the hold of the network. In the network this nodes are basic models of neurons. Depending upon the external input it processes the information and provides the output. Here, information is distributed throughout the inputs to all of the nodes. Input nodes are summed up after getting the weights. If the sum of all the inputs to a node exceeds some threshold value T, the node executes and produces an output which is passed on to other nodes or is used to produce some output response. In the simplest case no output is produced if the total input is less than T. But in case of difficult models, it depends on activation function for the output.

The human nervous system is believed to have about $3x10^{10}$ neurons. In contrast, a typical artificial neural network might have a hundred neurons also. Thus it is difficult to make parallel system which can works like the same.

ANN system works like the biological neural system and the operations related with its networks. ANN working principles are decided and processed like the natural human nervous system. They are the simplified models for processing of many intelligent abilities such as learning, generalization and abstraction and more. In case of decision making and predicting diseases it would be used as a useful tool too.

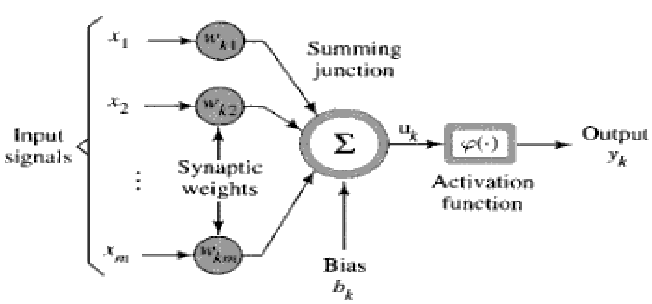

Figure 4. (a) Biological Neuron

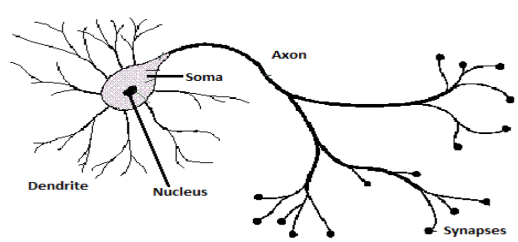

Figure 4.(b) Artificial Neuron

A schematic view of the biological neuron and artificial neuron is shown on Figure (a) and Figure (b) respectively. In case of biological neuron, signals from other neurons are conveyed to the cell body by dendrites. Then the signals are sent to the axon for distributing other neurons. On the other hand in artificial neuron, activations from other neurons are summed up at the neuron. The summed up neurons then passed through an activation function. Lastly other neuron receives the value and this process goes on continuing till the operation is reaching at the end.

This is the era where computing is really advanced, still there are some certain tasks or process which are not possible by the program made for any common microprocessor. Thus by developing software implementation of a neural network can be a solution for this.

V. Proposed Model

A. Input Data Set

The data have been acquired from interviewing various people at several departments of psychology in several medical colleges and hospitals in North Bengal. There were 200 observations for the study. The input is taken from ICD10 [14] standardization as GAD symptoms. The data have been standardized so as to be error free in nature. Below table shows the input parameters of our study:

TABLE I.Input Parameters

Sl. No.	Parameters	Column type
1	Duration	Numerical
2	accelerated heart rate	Categorical
3	Sweating	Categorical
4	Trembling or shaking	Categorical
5	Dry mouth	Categorical
6	Difficulty breathing	Categorical
7	Feeling of choking	Categorical
8	Chest pain	Categorical
9	abdominal distress	Categorical
10	depersonalization	Categorical
11	Fear of dying	Categorical
12	Muscle tension	Categorical
13	Restlessness	Categorical
14	mental tension	Categorical
15	difficulty with swallowing	Categorical
16	Difficulty in concentrating	Categorical
17	Persistent irritability	Categorical
18	Difficulty getting to sleep	Categorical
19	Fear of losing control	Categorical

B. GA Parameters

The parameters of GA which have been used to find the best solutions are given in table II.

These parameters are dependent of fitness functions. Moreover experimentation shows that the number of evaluations used does not compromise the results for selecting features.\

TABLE II.GA PARAMETERS

GA parameters	Values
Population size	50
Generations	50
Crossover rate	0.9
Mutation rate	0.1

C. Data processing

Data set have been processed through GA to get the best selected attributes among all attributes. Table III shows the selected fitness and id 1 is the best fitness:

TABLE III. TOP FIVE SELECTED FITNESS

Id	Features mask	Fitness
1	1100100110001010100	36.711525
12	1000110011100100001	36.711525
31	1101000011111000100	36.707203
35	1100110010100010101	36.707203
0	1101111101000001001	36.703335

VI. ANN ARCHITECTURE DEVELOPMENT

In this study, the multilayered feed-forward network architecture with 6 input nodes after feature selection of the input data, 15 hidden nodes and 1 output nod have been used for the neural network architecture. The numbers of input nodes are determined by the finalized data; the numbers of hidden nodes are determined through trial and error; and the numbers of output nodes are represented as a range showing the disease classification. The most widely used neural network learning method is the Quasi-Newton Algorithm.

Learning in a neural network involves modifying the weights and biases of the network in order to minimize a cost function. The cost function always includes an error term a measure of how close the network's predictions are to the class labels for the examples in the training set. Additionally, it may include a complexity term that reacts a prior distribution over the values that the parameters can take.

Out of selected mostly suited neural network architectures, the best suited architecture is found to be [6-15-1] with 121 weights. Below figure shows the neural architecture:

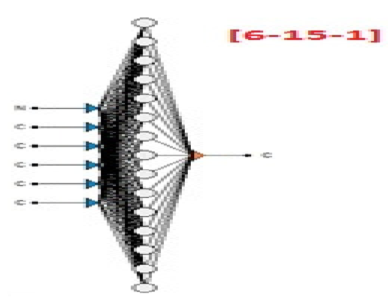

Figure 5. Best ANN Architecture

The hidden layer activation function is considered as logistic. The train error, validation error and test error is generated which are 1, 1 and 1 respectively. The AIC(Akaike's Information Criterion) value of the network is -1183.668579. This is the CCR(Correct Classification Rate)% graph after 501 iterations are done:

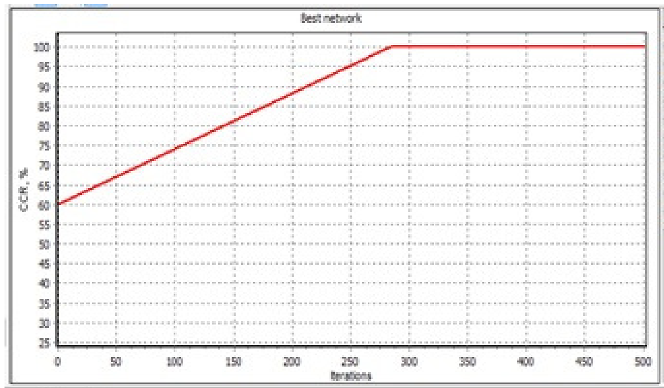

Figure 6. Best Network Graph

VII. RESULT AND DISCUSSION

The data set is divided into training set, validation set, testing set. The Data have been analyzed using Neuro-Intelligence Tool [15].

The column type is recognized during the data analysis. The last column is recognized as target output and others considered as input columns. After partitioning the data, the target output is compared with the actual output.

The following table shows the statistics of the data partition set.

TABLE III.DATA PARTITION SET

Partition Set	Records	Percentage (%)
Total	200	100
Training Set	138	69%
Validation Set	31	15.5%
Testing Set	31	15.5%
Ignore set	0	0

VIII. CONCLUSION

Now a day, for better treatment and management of any kinds of patient, right prediction of diseases is the utmost need for domain people. The study shows how efficient prediction can be done in GAD. Artificial Neural Network has been established of their importance in disease diagnosis also. This paper proposed a useful technique using GA and ANN for predicting GAD efficiently and accurately.

This technique is found very simple and requires fewer parameters to complete processing to optimize the parameters for developing expert system. Even ANN methods can helpful tools for decision making, classifying, and predicting disease and also be used by domain experts to cross-check their diagnosis, instead replacing the human experts.

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