The Hybrid Classification Model Thanks to Artificial Neural Network and Artificial Immune Systems for Diagnosis of Epilepsy from Electroencephalography

Sema Arslan and Hakan Işik

Abstract—**In this study, Artificial Neural Networks (ANN) and Artificial Immune (AI) techniques designed in the form of a hybrid structure are used for diagnosis of epilepsy patients via EEG signals. Attributes of EEG signals are needed to be determined by employing EEG signals which are recorded using EEG. In this process the raw digital signals data is received and is summarized in some respects. From this data, four characteristics are extracted for the classification process. 20% of available data is reserved for testing while 80% of available data is being reserved for training. These actions were repeated five times by performing cross-validation process. AIS is used for updating the weights during training ANN and a program is constituted for the classification of EEG signals. Education and recording processes were performed with different parameters by means of the constituted program. The obtained findings show that the proposed method was effective for achieving accurate results as much as possible with the use of ANN and AIS, together.**

Index Terms—**Artificial neural network, artificial immune systems, clonal selection, epilepsy, EEG signals.**

I. Introduction

In the study of Sakthivel *et al.* (2011), compared the fault classification efficiency of AIRS with hybrid systems such as principle component analysis (PCA)-Naive Bayes and PCA-Bayes Net. It has been observed that the AIRS-based system outperforms the other two methods considered in the present study [1].

In this study of Zhao *et al.* (2011), proposed a new machine learning method for complex systems by integrating the AIS system with RBFPLS. This new method demonstrates its satisfactory effect on classification accuracy for clinical diagnosis, and also indicates its wide potential applications to other diagnosis and detection problems [2].

In the study of Guo *et al.* (2010), have used to multi-classify 5 kinds of mental tasks for Immune Feature Weighted SVM (IFWSVM). Theoretical analysis and experimental results show that IFWSVM has better performance than Immune SVM (ISVM) without feature weight [3].

In the study of Şengür *et al.* (2008), investigated the use of principal component analysis (PCA), artificial immune system (AIS) and fuzzy *k*-NN to determine the normal and abnormal heart valves from the Doppler heart sounds. The validation of the proposed method is measured by using the sensitivity and specificity parameters; 95.9% sensitivity and 96% specificity rate was obtained [4].

In the study of Aickelinet *et al.* (2004), hoped that biologically inspired approaches in this area, including the use of immune-based systems will be able to meet this challenge. They collated the algorithms used, the development of the systems and the outcome of their implementation. [5].

In the study of Freitas *et al.* (2003), explained the potential pitfalls in representation selection and the use of various affinity measures. Then presents ideas on avoiding unnecessary mistakes in the choice and design of AIS algorithms and ultimately delivered solutions [6].

In the study of de Castro *et al.* (2002), presented the adaptation of an immune network model, originally proposed to perform information compression and data clustering, to solve multimodal function optimization problems [7].

In the study of de Hofmeyr *et al.* (2000), described an artificial immune which incorporates many properties of natural immune systems, including diversity, distributed computation, error tolerance, dynamic learning and adaptation, and self-monitoring [8].

In the study of de Coello *et al.* (2005), proposed an algorithm based on the clonal selection principle to solve multi-objective optimization problems (either constrained or unconstrained). Results indicate that the proposed approach is a viable alternative to solve multi-objective optimization problems [9].

II. Formun Alti-Material and Method

EEG signals are observed via vibrations of the electrical potentials (oscillations) that occur during brain activity through electrodes placed on the skull [10]. EEG signals are often referenced for understanding of the properties and the investigation of neurological and neuropsychological functions in the brain, today as well as for diagnostic and therapeutic purposes in many clinical [11].

A. Data Selection

In this study, EEG signals were taken from database described in Andrzejak *et al*. (2001). Feature vectors are removed using 4097 data obtained from epileptic patients and healthy individuals. Min, max, average and standard deviation is carried out for extracting this feature vectors.

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Thus, 200 data has obtained consisting of four feature vector.

From the obtained data, 20% was reserved for testing and 80% for training and these operations were repeated by 5 times by applying cross-validation.

B. Artificial Neural Networks Models

Artificial neural networks, modeled in the shape of the human brain to learn a method to try. An artificial neural network, called neurons, information processing consists of the elements. Neurons, sending a signal via the connection lines affect each other. These connecting lines each have a unique weight. These weights are calculated in the adaptive, information, reports the. Typically, the connection weights are determined by a learning process. Different weights can also be determined by the learning process is achieved by using the outcome information [12].

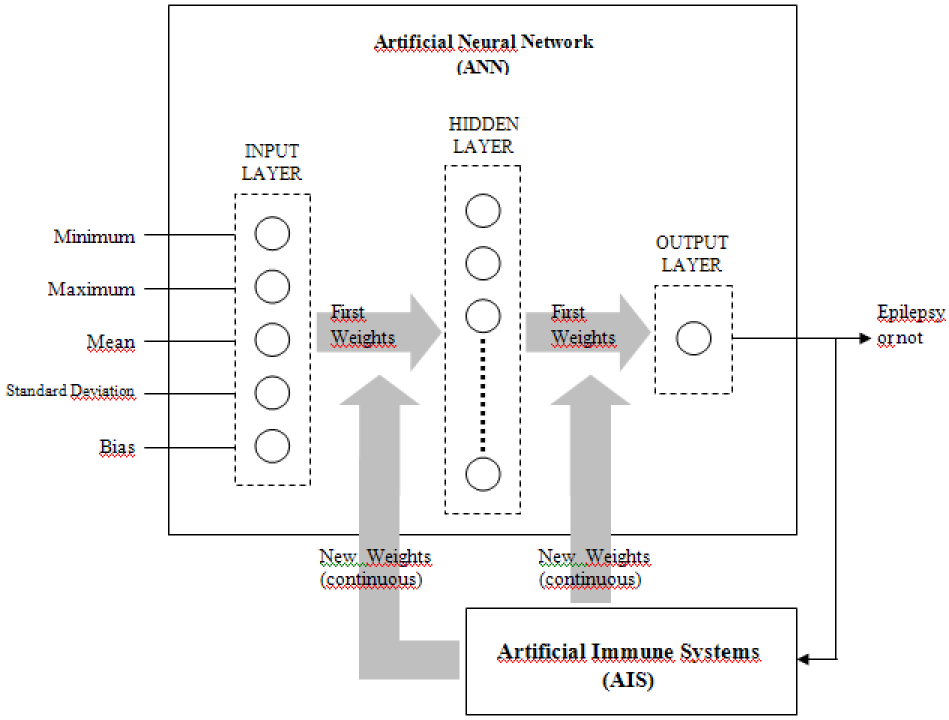

Fig. 1. Back-Propagation Multilayered Neural Network Structure with AIS.

C. Artificial Immune Systems

AIS; a complex model is applied to problem areas, in principle, observed immune functions and an adaptive system that was developed inspired by theoretical immunology [13]. The clonal selection algorithm, the immune system against an antigenic stimulus is used to describe the basic features. Recognize antigens only brings up the idea of these cells are selected in order to reproduce. The selected cells are subjected to the process of mutation enhances the similarities to the selective antigens [14].

III. Design of the Hybrid Model

AIS is used for updating the weights after finding the value of the output error in ANN model. Thus, a hybrid model was carried out with AIS. Fig. 1 denotes the structure of hybrid model with back-propagation neural network and AIS.

The network input consists of four feature vector and a bias. The output value is the state of presence or absence of epilepsy. Input values and hidden layer neuron number of the network consisting of one hidden layer determine the vector space (N) of AIS. The number of AI antibody changes depending on the number of neurons in hidden layer. In this model, the initial weight values are weights which are used in ANN. ANN and AIS are used in a hybrid structure for diagnosis of epilepsy disease. Sigmoid function is used to detect the output error values in feed-forward network structure. By means of the program written in Delphi language, finding the best weights and optimal number of neurons in hidden layer have been attempted.

IV. Experiments and Results

In this study, diagnosis of epilepsy via EEG signals has been tried by using ANN and AIS. The public database constituted by Andrzejak and colleagues have been employed for this purpose. The obtained results by entering different number of iterations and by entering different number of neurons in hidden layer have been provided in Table I. A higher accuracy rate has been achieved by means of the used network parameters in training, namely with an increasing number of antibody and neurons in hidden layer. 93%, 96% accuracy rates have been obtained when the numbers of antibodies are 5, 10. As can be seen in Table I, near 100% accuracy has been obtained from the test results in case of the number of iterations 100 and mutation rate 0.05. Furthermore the average success rate has been obtained as 95% from all test scores.

The weights are updated and optimum weight values are tried to be determined with structure of back-propagation by means of performed hybrid structure with ANN and AIS.

TABLE I: OBTAINED RESULTS FROM TEST DATA ACCORDING TO DIFFERENT PARAMETERS THAT ARE INCLUDED THE NUMBER OF NEURONS IN THE HIDDEN LAYER, ITERATION, ERROR RATE AND ANTIBODY THANKS BY HYBRID STRUCTURE OF ANN AND AIS.

Test Set Parameters	Neurons in Hidden Layer	2	4	6	2	4	6	2	4	6	2	4	6
	Iteration	50	50	50	100	100	100	50	50	50	100	100	100
	Error Rate	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
	Antibody	5	5	5	5	5	5	10	10	10	10	10	10
	Mutation Rate	0,01	0,01	0,01	0,05	0,05	0,05	0,01	0,01	0,01	0,05	0,05	0,05
Results	Results 1	98%	92%	78%	100%	100%	100%	100%	94%	96%	100%	100%	100%
	Results 2	62%	100%	94%	100%	100%	96%	62%	100%	100%	100%	100%	100%
	Results 3	50%	78%	98%	92%	100%	100%	50%	90%	100%	100%	100%	100%
	Results 4	82%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
	Results 5	80%	100%	98%	100%	100%	100%	100%	98%	100%	100%	100%	100%
Average (%)		93%						96%					
Average Success Rate (%)		95%											

In this study, only the feed-forward network structure has been used in ANN model, AIS algorithm has only been used for updating the weights. Thus, the optimum weights have been obtained with less number of iterations by means of AIS while updating the optimal weights of network. It can be observed more quickly whether a person has epilepsy from EEG signals by means of the developed program that will take place in the future and will be computerized.

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