**ABSTRACT**

In this research work, Artificial Neural Networks (ANN) has been used for depression classification. The purpose for which the artificial neural network used in the research work is, the existing methods are based on statistical parameters to classify depression to the expected accuracy. The purpose of using ANN for depression classification is due to the following reasons:

1. The working concepts of ANN are based on statistics, like using linear summation between layers, to propagate information from input to output layers,
2. ANN uses transformation function like sigmoid function for back propagation algorithm, exponential function in Radial basis function network, Hyperbolic tangent function in Echo state neural network to squash output values from neurons,
3. ANN uses objective function for finding optimal weights between layers for mapping inputs (information of depression) to outputs (category of depression).

Because of the working properties of ANN are based on statistical concepts, ANN assures correct classification of depression.

ANN is the mathematical representation of the functioning of neural connections in the human brain. The mathematical representation varies, depending upon the application. The ANN uses training algorithms. These algorithms are grouped under supervised, unsupervised and recurrent algorithms. While the supervised algorithms uses inputs and target outputs, the unsupervised algorithm uses only inputs, and the recurrent algorithms use inputs and target outputs along with previous outputs for training the topology of the ANN.

Back Propagation Algorithm (BPA) is used for training ANN topology. BPA uses the concept of forward propagation to find the error of ANN for a pattern. BPA uses reverse propagation for updating weights. When the
weights are optimal, so that there will be a close mapping among features of depression data with outputs in the output layer of ANN.

A multilayer feed forward network that uses an exponential activation function, is called Radial Basis Function (RBF). The RBF uses the concept of distance between patterns and the various centers of the patterns. The number of nodes in the hidden layer of the RBF network is equivalent to number of centers, used to find the distance. A bias value of 1 is appended to the hidden layer nodes for convenience of weight processing. The final weights are obtained between hidden layer and the output layer. These weights are used for classification of depression.

An Echo State Neural Network (ESNN) is a recurrent neural network. It contains input layer, hidden layer and output layer. Features extracted from depression data are processed with connection weights between input and hidden layer. The number of neurons (reservoirs) in the hidden layer decides the performance of ESNN. A tanH activation function is used in the hidden layer. State vectors are formed for each pattern. The state vectors are used to find the trained weights. These trained weights are used for classification of depression.

The major combinations of the algorithms used for depression classification are as follows:

1. Back Propagation Algorithm (BPA) for depression classification.
2. Echo State Neural Network (ESNN) for depression classification.
3. Radial Basis Function (RBF) for depression classification.
4. BPA with ESNN for depression classification.
5. BPA with RBF for depression classification.
6. RBF with ESNN for depression classification.

The methods implemented in this thesis for justification with respect to problem of depression classification are as follows:
1. The ANN can classify depression even if there is slight change in collected data.

2. The ANN can be trained with minimum patterns (<100 with unique depression data) and the ANN can classify depression.

Data mining is a concept of finding very close relationship among various features when a query is generated. The amount of exactness of the results obtained for a query is based on the type of algorithm used. Data mining is used to store and manage the multidimensional database system like depression data with 21 features.

In this research work, depression data of different patients have been collected from the hospital. Additional data have been simulated using the Matlab software.

In this research work, huge amount of data have been collected and generated and treated as raw data. Relevant features are extracted. The extracted features are stored in an acceptable format, so that it can be used for the proposed algorithms in this work. Training and testing of the proposed algorithms give an output in the form of classification to which the patient belongs.

The psychological depression data analysis is considered in this research work. Depression is one of the most common psychological conditions, affecting nearly everyone either personally or due to an affected family member. Depression can interfere with normal functioning and frequently cause problems with work, social and family adjustment. Serious depression can destroy the family life and the life of the depressed person.

A serious loss, illness, relationship problems, work stress, family crisis (like bereavement), financial setback, or any unwelcome life change can trigger a depressive episode. Very often, combinations of biological, psychological and environmental factors are also involved in the development of depressive disorders as well as other psychological problems. Some of the depression features considered are depressed
mood, feelings of guilt, suicide, insomnia early, insomnia middle, insomnia late, work and activities, retardation, psychomotor, agitation, anxiety, anxiety somatic, somatic symptoms, somatic symptoms general, genital symptoms, hypochondriasis, loss of weight, insight, diurnal variation, depersonalization, derealization, paranoid symptoms and obsessional and compulsive symptoms.

In order to evaluate the efficiency of the proposed algorithms in this research work, psychological depression data have been collected from general patients as well as from patients who have undergone different types of counseling from a hospital. The range of values a patient can have is considered based on the Hamiltonian rating scale. Many other evaluating scales can also be considered. Additional data have been generated considering the range of values and also considering the behavioral patterns of data that have been collected from the patients. This ensures that the data generated conform to the actual depression data.

The raw data have been categorized into four classes. Further the data have been separated into training and testing. This is achieved by normalizing the entire set of data. Subsequently, mean for each feature is found. Then summation of squared differences for each pattern is obtained. Redundant patterns are removed. The entire data set is reshuffled in the ascending order based on the summed value for each pattern. Sample patterns that belong to lower range and upper range of summed values are treated as training patterns, and the remaining patterns are considered as testing patterns. There are 21 features used as inputs, and one feature is used as target output for the proposed algorithms. In this work, ANN approach has been proposed for depression diagnosis.

The method of training patterns and testing patterns used for the implemented ANN are as follows:
1. Same number of training patterns and same number of test patterns are used for all the implemented algorithms.
2. Different number of training patterns and different number of test patterns are used for training the different algorithms.

The reason for choosing training and testing data into two different combinations are for evaluating the performance of the implemented algorithms for small number of training patterns and for large number of training patterns.

In order to find the optimum number of nodes required in the hidden layer of an ANN, a method has been proposed based on the change in the mean squared error dynamically, during the successive sets of iterations. By this process, optimum number of nodes in the hidden layer is obtained, meeting the convergence criteria and maximum depression classification.

The number of centers in the hidden layer of ANN trained by RBF algorithm is based on the maximum number of depression classification.

The number of reservoirs in the hidden layer of Echo State Neural Network (ESNN) is based on the maximum number of depression classification.

The contribution of this thesis in implementing ANN for depression classification is a promising direction of research for the scientific community. The combination of BPA with ESNN, the combination of RBF with ESNN, and the combination of BPA with RBF have given different possibilities of combining ANN for improving depression classification.

The relevance of mined solution for the given depression data is almost exact. The server can train the new input depression data rapidly and hence there will not be any slackness in the server in meeting the queries of the doctors. This research work is relevant in the present day scenario where even small children are stressed out and many adults at some point in time in their lives go through depression.