Prediction and Classification of cardiac Arrhythmia Using ELM

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Abstract - ***Cardiac Arrhythmia are classified by abnormal activity in the heart, Heart Rate Variability (HRV) is a non-invasive way of analysis for estimating the autonomic nervous system and based on the measurement of the variability of heart rate signals. HRV signal is the mostly noted for the cardiac arrhythmia detection and classification. In this paper, Neural Network is used to predict cardiac arrhythmias. The HRV data and RR interval time series is obtained using the Electro-cardiogram(ECG) data from the UCI machine learning repository arrhythmia dataset. A Few popular technique are used to classification and prediction of cardiac arrhythmia like support vector machine(SVM), naive bayes classifier. A new approach to classification and prediction of cardiac arrhythmia by Extreme Learning machine will provide effective result as compare to other algorithm. The proposed system will enhance the performance of prediction and classification.***

Key Words: *Artificial Neural Network, Extreme Learning Machine, feed forward Neural Network.*

1. INTRODUCTION

Heart diseases are the important health problem and main cause of the death of the patient. However, the early diagnosis and medical treatment of heart diseases can prevent sudden death of the patient. One of the tools to a diagnose heart diseases is to use ECG signals in hospitals. ECG is a graphical representation of the electrical potential generated by the heart and has been an invaluable diagnostic tool for the clinician [1].
ECG signals are consist of a P wave, QRS complex, and T wave. The regular heartbeat and ECG signal as illustrated in fig.1 [2]. In the normal heart beat, the main parameters include the shape, the duration of P wave, QRS complex, T wave and R-R interval. The changes in these parameters are indicate an illness of the heart that may occur by any reason.

All of the irregular beat phases are the generally called arrhythmia and some arrhythmias are very dangerous for patient.

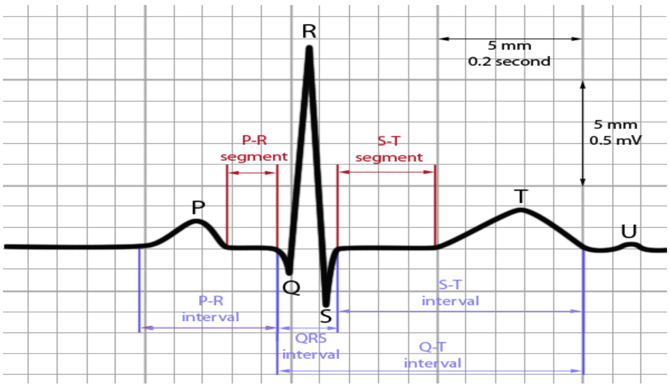


Figure 1. ECG Beats and intervals

Some ECG interpreting systems is available. Moreover, the computer-based interpreter systems are the currently being developed to diagnose arrhythmia in time, and various methods are applied to these systems with one of them being Extreme learning machine (ELM).

2. DATA SET

The dataset for the project is taken from the UCI Machine LearningRepository
https://archive.ics.uci.edu/ml/datasets/Arrhythmia

(1csv file, 1 information file).There are (452) rows, each representing the medical record of the different patient. There are 279 attributes like age, weight and patient's ECG related data.

The data set is labeled with a 16 different classes. Classes 2 to 15 correspond to different types of arrhythmia. Class 1 corresponds to the normal ECG with no arrhythmia and class 16 refers to unlabeled patient. The data set is heavily biased a towards the no arrhythmia case with 245 instances belonging to class 1 and 185 instances being split among the 14 arrhythmia classes and the rest 22 are unclassified.

3. CARDIAC ARRHYTHMIA PREDICTION BY ANN

An artificial neural network (ANN) is a massively the parallel distributed processor made up of simple processing units called neurons. The neurons have a natural capability for storing experiential knowledge and making it available for use [2].

Every neural network structure has the do undergo a training phase with the available data or patterns. This training / learning phase uses a suitable learning algorithm. The prime objective of the learning algorithm is to modify the synaptic weights of the network in an the orderly fashion so as to attain a desired design objective and to increase the accuracy of the learning stage minimizing the error. The working of ANN can be divided in two phases one is training phase and other is recalling phase or testing phase. In training phase both the input pattern and its corresponding target output is supplied to the network. Input is given to the network at input node, the input layer neuron processed the input by using activation function and gives its output. The output from this layer is given as input to the next level neuron, and so on up to the output node. The links connected between neurons are having

some weight. These weights are updated by some learning algorithm in training phase till the error between the network output and actual output for that input data set or pattern is minimized. The level of error depends on the learning algorithm, quality of data and type of network. Once the minimized error is obtained the other inputs are given to trained network to get the output. This is the recall phase or testing phase

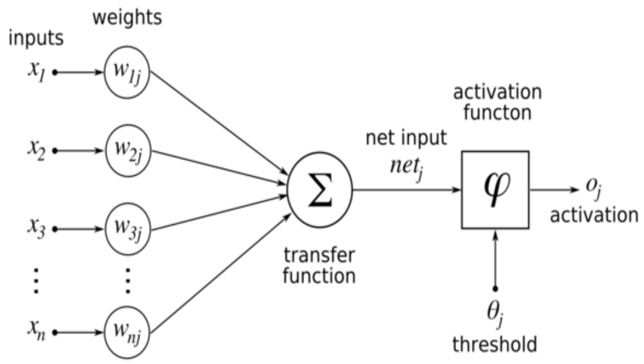


Figure 2. Architecture of neural network

This describes the modules, which should be considered design a good neural network model for price forecasting.

3.1 Input Selection

The aim of the input selection in the case of ANN is finding optimal input parameters. Using optimal inputs would result in smaller ANN with more accuracy and convergence speed. Parameters, which effect on the prediction and classification of Cardiac Arrhythmia can be categorized into age, patient history, RR Intervals, PQRST readings are selected by correlation analysis.

One of the reasons for using fewer features was the limited number of data records (452) compared to 257 features. This helps in avoiding over fitting and also gives insight into the important features which have maximum correlation with the output labels but minimal correlation among themselves.

3.2 Training

The ANN training process requires a set of examples with proper network behaviour (network inputs and target outputs). During training, the weights and biases of the ANN are is the iteratively adjusted to minimize the network performance function. the selected training method for the new ANN models is the Levenberg-Marquart back propagation (LMBP), which is a network training function that updates weight and bias values are according to Levenberg-Marquardt optimization.

This method is an improve Gauss-Newton method that has an extra regularization term is to deal with the additive noise in the training samples. In comparison to LMBP, conventional back propagation methods are often too slow for practical problems

Neurons in the hidden and output layers have nonlinear transfer function is known as the "tangent sigmoid".

The weighted inputs received by a tansig node are summed and passed through this function is to produce an output. The tansig function generates outputs between -1 and +1 and its inputs should be in the same range in the system. So, it is necessary to limit the ANN inputs and target outputs. Mean-standard the deviation and minimum (min)-maximum (max) normalization methods have been tested and min-max method has been selected:

This normalization method has also the advantage of mapping the target output to the non-saturated sector of the tansig function. This is the process helps to improve the accuracy of both the training and forecasting modes [3].

3.3 Output and Hidden Layer

The ANN models have the output layer. In the model of prediction and classification of cardiac arrhythmia the output is the weather, patient is having cardiac arrhythmia or not and if yes then which type of arrhythmia it is , so the output layer has the only one neuron.

The number of hidden layers and the number of the neurons in each layer are selected whereas the best results are obtained.

4. THE ELM-TREE APPROACH

4.1 Extreme Learning Machine

Extreme learning machines are feed forward neural network for classification or regression with a single layer of hidden nodes, where the weights connecting inputs to hidden nodes are randomly assigned and never updated. These weights between hidden nodes and outputs are learned in a single step.

The simplest ELM training algorithm learns a model of the form

$$\hat{\mathbf{Y}} = \mathbf{W}_2\sigma(\mathbf{W}_1 x)$$

where $\mathbf{W}_1$ is the matrix of input-to-hidden-layer weights, σ is some activation function, and $\mathbf{W}_2$ is the matrix of hidden-to-output-layer weights.

1. Fill $\mathbf{W}_1$ with Gaussian random noise

2. Estimate $\mathbf{W}_2$ by least-squares fit to a matrix of response variables **Y**, computed using the pseudo inverse $\cdot^+$, given a design matrix **X**:

$$\mathbf{W}_2 = \sigma(\mathbf{W}_1\mathbf{X})^+\mathbf{Y}$$

Given a training set X that contains N distinct instances with n inputs and m outputs, i.e. X={(**xi**,**yi**)|**x**i=[xi1,...,xin] T∈Rn, **y**i= [yi1,...,yim] T ∈Rm,i=1,...,N}, the SLFNs with ˜N hidden nodes and activation functiong(**x**) are formulated as where **w**j=[wj1,...,wjn]T is the weight vector connecting the input nodes and the j-th hidden node , bj is the bias of the j-th hidden node, βj=[βj1,...,βjm]T is the weight connecting the j-th hidden node and the output nodes, and **o** iis the output of **x**i in the network.

The standard SLNFs can approximate the N training instances with zero error, i.e., there exists **w**j, bj, and βj, such that:

∑j=1 βj g(**w**j · **x**i +bj) = **y**i, i= 1, . . . , N.

Algorithm1: Extreme Learning Machine–ELM.

Input: Training set {(**x**i,**y**i) | **x**i∈Rn , **y**i∈Rm, i=1,...,N}; activation function(**x**); the number of hidden node N.

Output: Input weight **w**j, input bias bj, and output weight β.

Steps:-

1. Randomly assign input weight **w**j and bias bj where
   j=1,...,N.
2. Calculate the hidden layer output matrix **H**;
3. Calculate the output weight β=**H**†**Y** where **H**† is the Moore–Penrose generalized inverse of matrix **H.**

4.2 Construct a ELM-Tree

The induction of ELM-Tree is described in Algorithm 3. There are two important parameters in Algorithm 3,i.e.,the truth level threshold θ ∈ [0,1], and the uncertainty coefficient ε ∈ [0,1]. For implementation, we further modify the uncertainty coefficient as ε × log2(m) for entropy-based ELM-Tree and ε × ln(m) for ambiguity-based ELM-Tree, where m is the number of classes in X.

Input: A training set with N instances, n attributes and m classes; truth level threshold θ ∈ [0, 1]; uncertainty coefficient ε ∈ [0, 1];
And integer parameter N^* ∈ {1... N}.

Output: An ELM-Tree.

Steps:-

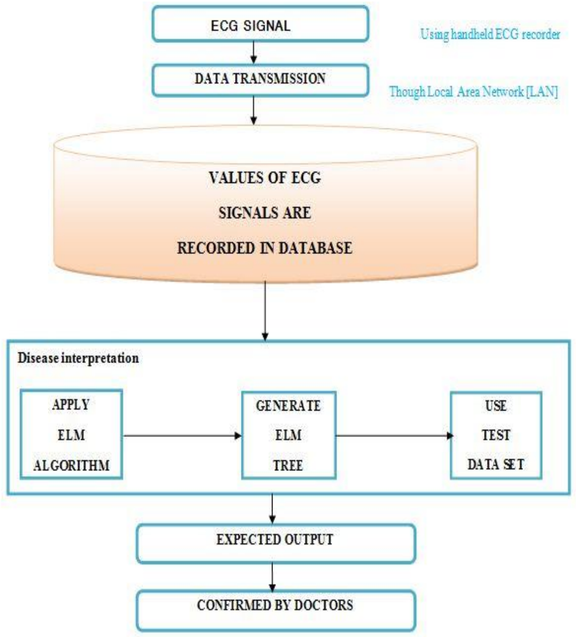
Ω is initialized as an empty set;
Consider the original training set as the root-node, and add it to Ω;
While Ω *is not empty* **do**
Select one node from Ω, denoted by X;
if max$\{p_i\}^m_{i=1}$ > θ *or* |X| <N^* **then**
Assign X a label, i.e., $\text{argmax}_i \{p_i\}^m_{i=1}$,and remove it from Ω;
else
if I(cut_{ij}) < ε *for* i=1,...,N−1,j=1,...,n **then**
Train an ELM for X and remove it from Ω;
else
Split X into two child nodes X1 and X2

by Algorithm2;
Remove X from Ω, add X1 and X2 to Ω;
end
end
end

5. PROPOSED SYSTEM

To develop an application for prediction and classification of cardiac arrhythmia by applying Extreme Learning machine, thus making it faster, efficient and reducing complexity and high accuracy

5.1 System Architecture:-



5.2 Modules-:

1. ECG Signal Measurement

ECG signal recorder is an electronic machine it will gives ECG signals values. That values helps for further disease prediction.

2. Data Transmission

Local Area network cable is very useful for data transmission from ECG signal recorder to System.

3. Storing Information In Database

The values and information that system get is stored into the database.

4. Apply Elm Algorithm

ELM is Extreme Learning Machine Algorithm comes in the Neural Network. ELM is well suited algorithm for prediction, so ELM algorithm is applied on the data or information present in the database.

5. Generate Elm Tree

This Model will generate an ELM tree. Which show's actual system using neural network.

6. Use Test Dataset

In Test data set various symptoms values are stored by using those values, System will predict the type of disease

6. CONCLUSIONS

In earlier times the mastery of reading different ECG signals and their comparison with standard available data was required, but still there were chances of missing important diagnosis which may leads to death in certain cases. So in order to avoid any risk the computerized reorganization and classification of Electrocardiography signals has drawn the attention of researchers for the last decades. Several algorithm have been reported for the detection and classification of ECG beats. Improvement is possible after the reported results of several algorithms for signal processing which include the use of neural network. The ELM algorithm will gone very useful for implementation of Cardiac Arrhythmia Disease with very much accuracy and fast.

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