Application of A Radial Basis Function Neural Network for Diagnosis of Diabetes Mellitus

Kay Thi Win, Zin May Aye
University of Computer Studies (Mawlamyine), Myanmar
09kaythiwin@gmail.com

Abstract

In this paper, an attempt is made to study the applicability of a general purpose, supervised feed forward neural network with one hidden layer, namely; Radial Basic Function (RBF) neural network. It uses relatively smaller number of locally tuned units and its adaptive in nature. RBFs are suitable for pattern recognition and classification. An artificial neural network with radial basic function is applied for the diagnosis of diabetes mellitus system This system consists of three phases: preprocessing, training and testing.

1. Introduction

Diabetes Mellitus (DM) is a chronic and progressive metabolic disorder, where according the World Health Organization there are approximately 171 million people in this world suffering from diabetes. Diabetes mellitus is a group of metabolic diseases characterized by high blood sugar (glucose) levels, that result from defects in insulin secretion, or action, or both. Diabetes mellitus, commonly referred to as diabetes was first identified as a disease associated with "sweet urine", and excessive muscle loss in the ancient world. Elevated levels of blood glucose (hyperglycemia) lead to spillage of glucose into the urine, hence the term sweet urine. Normally, blood glucose levels are tightly controlled by insulin, a hormone produced by the pancreas. Insulin lowers the blood glucose level. When the blood glucose elevates insulin is released from the pancreas to normalize the glucose that level. In patients with diabetes, the absence or insufficient production of insulin causes hyperglycemia.

In this system the application of the radial basic function (RBF) Artificial Neural Network (ANN) is used for the diagnosis of diabetes mellitus. The function (RBF) networks employs the same network architecture as multilayer perceptrons, but different activation functions. In this system the Gaussian function is used as an activation function for the network to modify the input to give the desired output. The transfer function is chosen such that the algorithm requires a response function with a continuous, single-valued with first derivative existence. Artificial Neural Network (ANN) is an information processing paradigm that is inspired by the way of biological nervous systems, such as the brain, process information. The key element of this paradigm is the novel structure of the information processing system. In ANN, it has three layers: an input layer, a hidden layer and an output layer. The hidden layer vastly increases the learning power of the multilayer perception. ANN is composed of a large number of highly interconnected processing elements (neurons) working in unison to solve specific problems. Choice of the number of the hidden layers, hidden nodes and type of activation function plays an important role in neural network construction. ANN has supervised and unsupervised learning. Radial Basic Function is a supervised learning. A radial basis unction (RBF) network has a hidden layer of radial units, each actually modeling a Gaussian response surface. Since these functions are nonlinear, it is not actually necessary to have more than one hidden layer to model any shape of function: sufficient radial units will always be enough to model any function. It turns out to be quite sufficient to use a linear combination of these outputs (i.e., a weighted sum of the Gaussians) to model any nonlinear function.

This paper is organized as follows. Section-2, the related work. In Section 3, theory background related to this system is presented. Section 4, presents the design and implementation of this system. In Section 5, conclusions of this paper is described.

2. Related Work

Neural networks have seen an explosion of interest over the last few years, and are being successfully applied across an extraordinary range of problem domains, in areas as diverse as finance, medicine, engineering, geology and physics. Neural networks are very sophisticated modeling techniques, capable of modeling extremely complex functions [3]. Traditional manual data analysis has become inefficient and methods for efficient computer-based analysis are essential. It has been proven that the benefits of the introducing machine learning into medical analysis are to increase diagnostic accuracy, to reduce cost and to reduce human resource[8].

Different types of neural networks such as neural fuzzy system, multilayer perceptron, radial basic function, Elman neural network, wavelet neural network and time-series convolution neural network can be applied widely addressing the prediction of the diagnosis in diabetes mellitus systems [9]. Neural networks can accommodate a combination of continuous variables and discrete numeric variables. In this system radial basis function neural network is used to apply in diagnosis of diabetes mellitus. Radial basis functions (RBF) are originally developed by Hardy to fit irregular topographic contours of geographical data [1, 6]. RBF networks enjoy the best approximation property among all feed-forward networks and which have produced excellent fits to arbitrary contours of both deterministic and stochastic response functions [7].

3. Background

The related background theory of artificial neural network used in this system is described in this section.

3.1 Artificial Neural Network (ANN)

This section provides an overview of ANN. First, computational models of neurons are introduced. Then, the important issues of network architecture and learning are discussed. Various ANN models are organized by their architecture and the learning algorithm involved [1].

3.1.1 Network Architecture

An assembly of artificial neurons is called an artificial neural network. ANNs can be viewed as weighted directed graphs in which nodes are artificial neurons and directed edges (with weights) are connections from the outputs of neurons to the inputs of neurons. Based on the connection pattern (architecture), ANNs can be grouped into two major categories (i) feedforward networks in which no loop exists in the graph, and (ii) feedback(or recurrent) networks in which loops exist because of feedback connections. The most common family of feedforward networks is a layered network in which neurons are organized into layer with connection strictly in one direction from one layer to another discuss in this papers all these networks except for the Radial Basis Function (RBF) networks which employ the same network architecture as multilayer perceptrons, but different activation functions. Different connectivity yield different network behaviors. Feedforward networks are memoryless in the sense that the response of a feedforward network to an input is independent of the previous state of the network. Recurrent networks are dynamic systems. Upon presenting a new input pattern, the outputs of the neurons are computed. Because of the feedback paths, the inputs to each neuron are then modified, which leads the network to enter a new state. Different network architectures require different learning algorithms.

3.2 Radial Basic Function (RBF)

RBF is emerged in late (1980's) in a variant of neural network [3]. The activation function of the hidden layer is dependent on the distance between the input vector and the prototype vector. RBF includes function approximation, regularization, noisy interpolation, density estimation, optimal classification theory and potential functions. RBF have two kinds of training algorithms. They are supervised and unsupervised. RBF networks are used mainly in supervised application. In this case, both data set and its output is known. RBF are embedded into two layers of feed-forward neural network. Such a network is characterized by a set of input and a set of output. In between input and output layers there is processing units called hidden units. RBF has three layers. Figure 1 represents the RBF neural network. In this system, the input layer and hidden layer consist of ten nodes and output layer consists of only one node because the input layer to hidden layer mapping is non linear and the hidden layer to output layer mapping is linear.

Input layer: Source nodes that connect to the network to its environment.

Hidden layer: Hidden units provide a set of basis function and high dimensionality.

Output layer: Linear combination of hidden functions.

Each of them implements a radial basis function. The way in which the network is used for data modeling is different when approximation time-series and pattern classification. In a pattern classification application the input represents feature entries, while each output corresponds to a class.

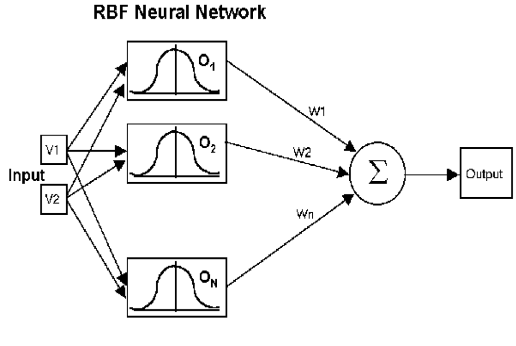

Figure 1. RBF neural network

4. System Design and Implementation

This section presents the system design and the implementation of the system. Figure 2 describes the system design of this system. First input data are read from the system and then the network initializes the required parameters (number of neurons, target, random weight, momentum and learning rate) to process in the RBF neural network. Then the hidden layer is initialized and network is trained with the training data. The output can determine the percentage of the Diabetes Mellitus that the user has to be suffered.

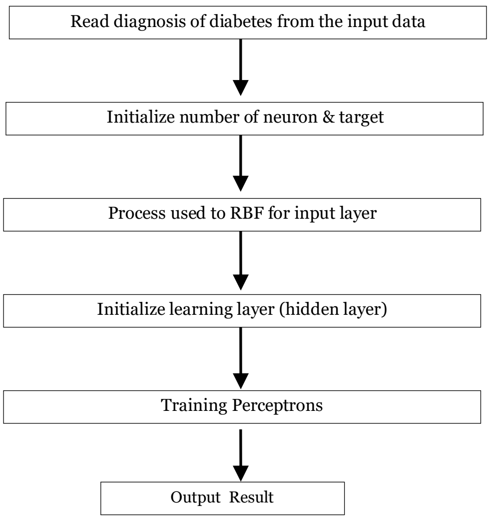

Figure 2. System Design

This system has three phases: preprocessing, trainings and testing.

4.1 Preprocessing Phase

In this preprocessing phase, training program translates the input to the only binary numbers.

4.2 Training Phase

In the training phase, it is needed to initialize the weight and other required parameters randomly. The input data from the user are accepted for the network to be trained. Then the network calculates the net input and actual output for each hidden neuron by using Euclidean norm. Gaussian activation function is used to calculate output value for each hidden neurons. The net output for the output layer is calculated by using activation potential function (H(x)). Then the network computes error between target and actual output from the network and change and update weights depending on predefined sum squared error and maximum error. Training program continues until the maximum error is less than the value of sum squared error. In this system about fifty training data set are used for the input data.

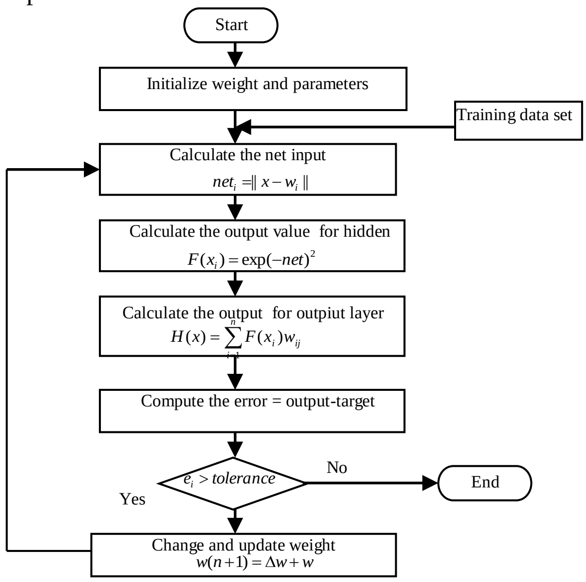

Figure 3. Training Phase of the System

4.3 Testing Phase

In this testing phase, the inputs data from the user are captured for the testing data. The input system consists of critical facts for the diabetes mellitus that are needed to determine the result of the system. The testing network consists of only feed-forward propagation. The testing network uses training network's weight as it's knowledge. As the network is a testing network, it does not need target output Figure 4 depicts the testing phase of the system. In this phase the testing data and the trained weight are applied as the input to the network. Output value for input unit can be determined from the Euclidean norm. If the user gives the testing input to the testing network, the network will show the result output in percentage that the user has to be suffered the Diabetes Mellitus.

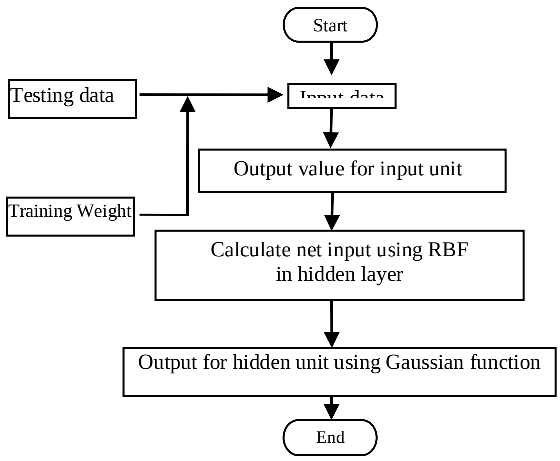

Figure 4. Testing Phase of the System

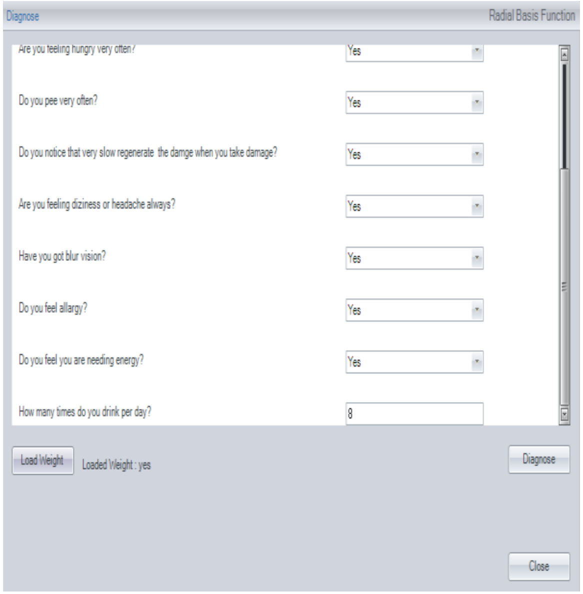

Figure 5. User's Input data for testing

Figure 5 shows the user's input data to the system for testing. The symptoms of diabetes Mellitus that can be mostly found in the diabetes patients are presented and the user's answers for the given questions are used for the testing data in the network. The followings are the some of the input data for the system that a user can choice the answer Yes or No depend on the questions. In this system, thirty testing data set are used for the testing in the network. The user is needed to choose the optimal weight for the system.

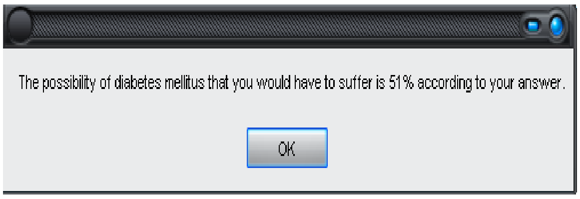

Figure 6. Output Result for a user

After answering the required facts from a user of this system, the testing the system will calculate the percentage of the possibility of the diabetes mellitus that the user has to be suffered as shown in Figure 6

5. Conclusion

This system is developed by pattern classification for diagnosis of diabetes mellitus using Radial Basis Function Neural Network (RBFNN). RBF is good for approximation than other approximation methods. The critical facts based on the diabetes mellitus are used for training and testing data set. Diagnosis of diabetes is classified using RBF NN. The external data can be used to test the knowledge of the network. The result is expressed in percentage of diabetes that a user has to be suffered. When the classification is the goal, the neural network model will often deliver closed to the best fit. The present work was motivated in this direction.

References

[1]. A. Shahsavand and A. Ahmadpour. "Application of Optimal Rbf Neural Networks for Optimization and Characterization of Porous Materials." Computers and Chemical Engineering, vol 29 pp. 2134-2143, 2005.

[2]. Christos Stergiou and Dimitrios Siganos (NEURAL NETWORKS)

[3]. Lihui Ma, Kunlun Xin, and Suiqing Liu (Using Radial Basis Function Neural Networks to Calibrate Water Quality Model

[4] P. Venkatesan* and S. Anitha (Application of a radial basis function neural network for diagnosis of diabetes mellitus)

[5] Ravi Kaushile (project 1, csc 84010, neural network and pattern reorganization)

[6] R. Jin, W. Chen and T. W. Simpson. "Comparative Studies of Metamodelling Techniques under Multiple Modeling Criteria." Struct Multidiscip Optim, vol 23, pp. 1-13, 2001

[7]. S. Lingireddy and L. E. Ormsbee. "Neural Networks in Optimal Calibration of Water Distribution Systems." Artificial Neural Networks for Civil Engineers: Advanced Features and Applications, vol, pp. 53-76, 1998

[8]. K.Kayaer, T. Yildirin (Medical Diagnosis oon Pima Indian Diabetes)