



Study and Review of Genetic Neural Approaches for Data Mining

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Abstract: Data mining techniques are used to explore analyze and extract data using complex algorithms in order to discover unknown patterns. Neural network which is one of the data mining techniques was proved to be universal approximator. Neural network is able to learn a mapping between input and output nodes while the hidden nodes and weights between them contain the internal representation of the input which trains the network with local convergence. As the initialization of neural network weights is a blind process and neural network is slow to converge then it is difficult to find global optimal solution. A fixed structure of the neural network may not provide the optimal performance within the training period so the number of hidden layers and hidden nodes for particular neural network also plays an important role. Hence, this paper presents a Genetic Neural Network technique that takes advantage of global optimization of genetic algorithm for initialization of neural network along with the calculation of the number of hidden nodes and hidden layers for neural network which train the network with proper selection of neural network architecture.

Keywords: Neural network, genetic algorithm, data mining

I. Introduction

Data mining is one of the most important steps of the knowledge discovery in databases process and is considered as significant subfield in knowledge management.[1] Data mining an interdisciplinary subfield of computer science is the computational process of discovering patterns in large dataset involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. Thus data mining is decision tree, neural network, rule induction, nearest neighbour, genetic algorithm.

Artificial neural network, a data mining practice, is a interconnected group of artificial neurons that uses mathematical model or computational model for information processing based on connectionist approach of computation.[2] Neural Networks are form of a multiprocessor computer system, with simple processing elements, a high degree of interconnection, simple scalar messages, and adaptive interconnection between elements. Thus, neural computing is a information processing paradigm, inspired by biological system, composed of a large number of highly interconnected processing elements(neurons) working in unison to solve specific problem.

As the Neural networks are models of biological neural structures. The starting point for most neural networks is a model neuron, as in Figure 1. This neuron consists of multiple inputs and a single output. Each input is modified by a weight, which multiplies with the input value. The neuron will combine these weighted inputs and, with reference to a threshold value and activation function, use these to determine its output.

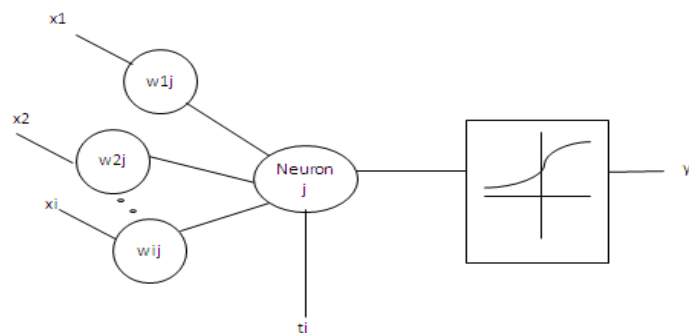


Figure1: A model of neuron

A. Neural Network Architecture

A neural network is usually a layered graph with the output of one node feeding into one or many other nodes in the next layer. An Artificial Neural Network Architecture is a data processing system, consisting of large number of interconnected processing elements such as neurons in a network structure that can be represented by using directed graph G , an order 2 tuple (V, E) , consisting of set V of vertices and set E of edges. The Vertices may represent neurons (input/output) and the edges may represent synaptic links labeled by weights attached.[3] The multiple layers are arrayed one succeeding the other so that there is an input layer, multiple intermediate layers and finally an output layer, as in Figure 2. Intermediate layers, that is those that have no inputs or outputs to the external world, are called hidden layer. In fully connected network each neuron is connected to every output from the preceding layer or one input from the external world if the neuron is in the first layer and, correspondingly, each neuron has its output connected to every neuron in the succeeding layer.

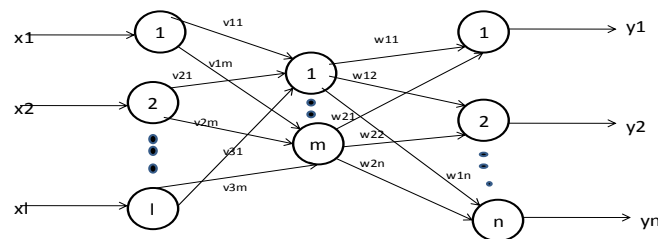


Figure 2: Multi-Layer Feedforward Network

The output of each neuron is a function of its inputs. In particular, the output of the j th neuron in any layer is described by two sets of equations:

$$U_j = \sum (X_i * w_{ij}) \text{ [Eqn 1] and}$$

$$Y_j = F_{th}(U_j + t_j) \text{ [Eqn 2]}$$

For every neuron, j , in a layer, each of the i inputs, X_i , to that layer is multiplied by a previously established weight, w_{ij} . These are all summed together, resulting in the internal value of this operation, U_j . This value is then biased by a previously established threshold value, t_j , and sent through an activation function, F_{th} . This activation function is usually the sigmoid function, which has an input to output mapping as shown in Figure 4. The resulting output, Y_j , is an input to the next layer or it is a response of the neural network if it is the last layer.

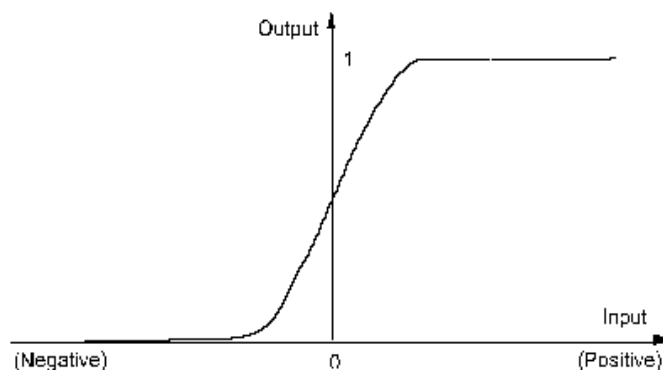


Figure 3: Sigmoid Function

In essence, Equation 1 implements the combination operation of the neuron and Equation 2 implements the firing of the neuron [3].

From these equations, a predetermined set of weights, a predetermined set of threshold values and a description of the neural network it is possible to compute the response of the neural network to any set of inputs. The weights in artificial neurons are adjusted during training process.[4]

Neural network acquires knowledge through learning. In general, the learning steps of a neural network are as follows. First, a network structure is defined with a fixed number of inputs, hidden nodes and outputs. Second, an algorithm is chosen to realize the learning process. The recent vast research activities in neural classification have established that neural networks are a promising alternative to various conventional classification methods.[5]

Although significant progress has been made in classification related areas of neural networks, a number of issues in applying neural networks still remain and have not been solved successfully or completely. Neural network trains the input data pattern through different layers with local convergences which does not provides optimal solution to the problem. The network architecture plays important role in training the input data.

Thus proposed system in this paper focus on uses of genetic algorithm for finding the global optimal solution along with the proper selection of the neural network architecture.

The rest of the paper is organized as follows. In Section II, neural network structures and learning processes for data mining. In Section III, the Genetic Neural Network with proper selection of neural network architecture for data mining is proposed.

II. LITERATURE SURVEY

Neural networks are trained by using various learning techniques. The learning process of neural network uses different approaches for knowledge discovery. Different researchers have studied different neural networks learning approaches using different optimization techniques. As the neural network learn about the input data by its own this leads to mine the data to discover pattern. Neural network process the data pattern between input and output layer along with the hidden layers. The synaptic weights initialization and hidden layer identification is done by various ways to have optimal convergence.

Frank H. F. Leung, H. K. Lam, S. H. Ling, and Peter K. S. Tam[6] proposed a three-layer neural network with switches introduced in some links is proposed to facilitate the tuning of the network structure in a simple manner. The number of hidden nodes is chosen manually by increasing it from a small number until the learning performance in terms of fitness value is good enough.

Teresa B. Ludermitr, Akio Yamazaki, and Cleber Zanchettin[7] developed the approach that combines the advantages of simulated annealing, tabu search and the backpropagation training algorithm in order to generate an automatic process for producing networks with high classification performance and low complexity.

Chi-Keong Goh, Eu-Jin Teoh, and Kay Chen Tan[8] described a hybrid multiobjective evolutionary approach to ANN design which stochastic or performance driven and estimate the necessary number of neurons to be used in training of only single-hidden-layer feedforward neural network.

David Hunter, Hao Yu, Michael S. Pukish, Janusz Kolbusz, and Bogdan M. Wilamowski. [9] performed comparison between different learning algorithms the Error Back Propagation (EBP) algorithm, the Levenberg Marquardt (LM) algorithm, and the recently developed Neuron-by-Neuron (NBN) algorithm, and different network topologies, including traditional Multilayer Perceptron (MLP) networks, Bridged Multilayer Perceptron (BMLP) networks, and Fully Connected Cascade (FCC) networks. They used the trial and error approach to find number of layers and number of neuron in each hidden layer. Out of this FCC architectures are proved to be powerful with largest number of connections across layers per number of neurons. Since the power of the FCC network increases dramatically with the number of neurons, usually not many trials are required, but FCC is required to provide the architecture with acceptable training error and the smallest number of neurons.

Syed Umar Amin, Kavita Agarwal, Dr Rizwan Beg[10] developed the hybrid system that uses global optimization advantage of genetic algorithm for initialization of neural network weights. This technique uses the backpropagation algorithm to train the networks using the weights optimized by Genetic Algorithm.

To determine the structure of network is challenging. A small network may not provide good performance owing to its limited information processing power. A large network, on the other hand, may have some connections redundant. As the structure of the network plays important role. Hence, it is possible by the proposed approach to determine the number of inputs, layers and hidden neurons of the neural network and then to initialize the neural weights by genetic algorithm.

III. PROPOSED SYSTEM

Architecture design of the neural network can be formulated as optimal problem. Optimization of neural network architectures and weights is an interesting approach for the generation of efficient networks. As the neural network learn through different layers which maps the input between input and output layer with hidden layers and weights as internal part till the network converge locally so it is important to select proper size, topology of the network and proper weight initialization for the network.

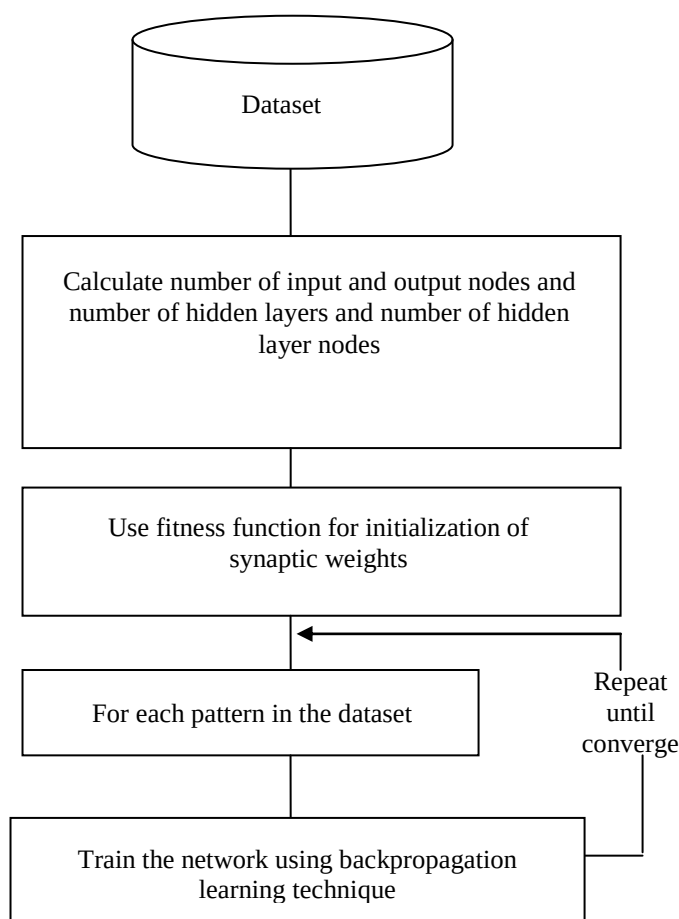


Figure 4: Proposed System

The proposed system of neural network with genetic algorithm shown in Figure 4 uses the genetic algorithm fitness function to initialize the weights that would make possible to have global optimal convergence. Neural network architecture can be constructed by identifying the input and output layer neuron along with number of hidden layers and hidden nodes identification. So when this improved genetic neural network approach applied to the data set can construct the network depending on the input dataset and can initialize the weight by fitness function of genetic algorithm. Genetic Algorithm is adaptive heuristic search algorithm based on the evolutionary ideas of natural selection and genetics. Thus Genetic-Neural Network takes the advantage of global optimization of genetic algorithm for initialization of neural network.

IV. CONCLUSION

In this paper, a Genetic Neural approach which uses Neural Networks and Genetic Algorithm to optimize the connection weights of ANN so as to improve the performance of the Artificial Neural Network along with the determination of the structure of the neural network is proposed. This proposed method could be able to provide fast learning, more stable and select the neural network architecture with acceptable training error and smallest number of neurons. Considering appropriate dataset the proposed method can be implemented in future.

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