Realization of Neurons with Multiple Thresholds for XOR Operations in BP Networks Based on Fuzzy Genetic Algorithms

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Keywords: Fuzzy genetic algorithm; BP network; Multi-threshold neuron

Abstract: The principle of realizing multi-threshold neuron nonlinearity by using fuzzy genetic algorithm BP network is analyzed, and the XOR operation by using neurons is taken as an example. To solve the unsolvable problem caused by inappropriate selection of initial values of connection weights and thresholds of BP neural network, a fuzzy genetic algorithm for approximation of global optimal solution and an exact value of local optimal solution are combined. At the same time, the initial weights and thresholds of neurons are optimized by using the fuzzy genetic algorithm, and three basic operations in logic are realized by using a multi-threshold neuron. The multi-threshold neuron of this basic operation can form a multi-threshold neural network that implements arbitrary ternary functions. Since the ability of single neuron information processing is improved, the optimization result is used as the initial value of the BP network and then trained by BP network. The network, so alternately runs the BP network and the fuzzy genetic algorithm until the accuracy required by the problem is reached.

1. Introduction

Neuron is the basic unit of neural network. It plays a decisive role in the scale, complexity and robustness of the whole network [1]. Neural network is composed of many interconnected single neurons. It can realize large-scale neural network with reconfigurable, flexible and simple mechanism units. In fact, the relation of number logic can be summed up as input-output mapping of binary Boolean function [2]. Therefore, the transmission of different heterogeneously driven multi-order modulation formats directly increases the complexity of the new generation optical transmission system. In order to obtain heterogeneous transmission service information and allocate the best transmission path, it is necessary to adopt various modulation formats for the transmission channel [3]. A single neuron can implement binary arithmetic basic operations, but it is difficult to implement XOR operation because a single single-threshold neuron cannot solve the nonlinear partition problem in the classification process [4]. Simulate multi-threshold neurons with good prediction accuracy. The random selection of the initial threshold and initial weight of neurons in the neural network will make the BP network obtained after each training and learning have large differences. A small initial value is set for the network weight and threshold, and then a training sample set is selected to calculate the error relative to this sample set. If the gradient of each layer is known, the connection weights and thresholds can be updated according to the learning rules until the algorithm converges [5].

Multi-threshold neurons have multiple elucidation values and activation states, which can play the role of multiple single-threshold neurons in pattern classification, and can reduce the number of neurons in the same pattern classification function [6]. Combining the theory of fuzzy set, neural network and fuzzy genetic algorithm, we can express people's knowledge and experience with the concept of fuzzy, make use of the strong learning ability of neural network, and combine the characteristics of global search of fuzzy genetic algorithm. Multilayer network for weight training of non-linear differentiable functions [7]. It is mainly used in function approximation, pattern recognition, classification and data compression. In dynamic networks, the dynamic characteristics of networks lead to the dynamic changes of network topology and the dynamic selection of routing. Service transmission quality is one of the important bases for dynamic routing selection [8]. Threshold neurons require three neurons to achieve, which shows that the use of multi-threshold

neurons can significantly reduce the number of neurons in the neural network [9]. The initial values of weights and thresholds are generally randomly generated. Therefore, the solution obtained by training is not necessarily the most accurate solution of the whole. The strain and each influencing factor are input variables, and the stress is used as the output variable to construct the neural network structure. The neural network is trained by using the above-mentioned experimental data as the training sample, and the generated neural network is used for identification and there will be a large error. In the pattern classification, it can play the role of multiple single-threshold neurons, which can greatly reduce the number of neurons in the neural network of the same pattern classification function [10].

2. Materials and Methods

Fuzzy optimization neural network prediction incorporating fuzzy genetic algorithm can accelerate the convergence speed of the network and improve the global optimization ability of the network. In this way, not only the prediction efficiency can be improved, but also the prediction accuracy can be higher. The only way to enhance the classification ability of the network is to use multi-layer network, that is, to add hidden layer between input and output layers. In fact, the training process of neuron network is a trial-and-error process, which continuously limits the weights and thresholds that can meet the conditions through a large number of paired input of known parameters and output of known solutions. The input signal enters the cell body after weighted summation of synapses and dendrites. The cell body is actually a threshold processing unit. It judges the value of the summation signal. If the summation signal is between the threshold "0.5" and the threshold "1.5", the activation signal "1" is generated. Multi-threshold multi-valued neurons can implement any logical function of any cardinal multi-valued logic with N inputs and one output. The unoptimized BP neural network structure, its initial weight/threshold value is randomly assigned by the system. It is necessary to start from these groups, simulate the evolution process, select the best and eliminate the bad, and finally obtain very good groups and individuals to meet the optimization requirements. The initial weight/threshold of the optimized BP neural network is optimized by fuzzy genetic algorithm. The optimized BP network structure is shown in Figure 1.

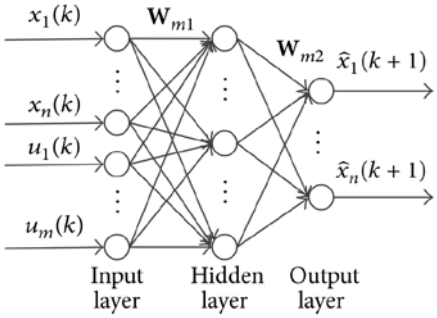

Figure 1 Optimized BP Network Structure Diagram

Multi-threshold neurons have the characteristics of multi-region non-linear partition in multi-dimensional space, so a neuron can be used to realize multi-logic functions with arbitrary N variables and arbitrary cardinality. Fuzzy genetic algorithm (FGA) is used to optimize the connection weights of FNN, which is to code the connection weights of FNN, form chromosomes, and then simulate the evolution process of nature. The output values of neurons in different threshold intervals and the rising or falling thresholds of neurons are different. This multi-threshold neuron can not only divide the space into several ultra-flat bands, but also give these ultra-flat bands different activation states. Artificial neuron network with fuzzy genetic algorithm can avoid falling into local optimal solution, and optimize the initial value of BP network neuron weight/threshold when the training data range is limited. That is, the fuzzy genetic algorithm is used to search for the optimal initial weight/threshold within the entire range of values of the weight/threshold, which can

maintain a good fault tolerance for a relatively large data range during testing. In network identification problems, it is often necessary to search for optimal estimates within a dynamic data range. The pattern classification in any two-dimensional space is to find a series of parallel lines in a two-dimensional plane coordinate, which can divide the plane into multiple regions.

Multi-threshold and multi-valued neurons are especially suiTable for describing multi-valued logic operations because they can divide multiple regions in multi-dimensional space and generate different activation states in different regions. The approximate value of the global optimal solution is obtained, not the exact value; the exact value of the local optimal solution can be obtained. Therefore, the problem of non-convergence caused by BP network oscillation caused by improper initial weights/thresholds is avoided. The two-threshold neuron that implements the XOR operation can form a forward neural network to realize the home position and operation of a full adder. The carry operation of the full adder can be composed of a single threshold neuron combination. Trained and tested as input data based on neural networks, through simulation, sparse signal sets and complete signal sets in neuron-based network recognition. Multi-threshold neurons can have multiple output values, and the output transfer characteristics have multiple rising and falling thresholds. The exponential function of multi-threshold neurons is essentially a multi-value discriminant function. Its form is a two-dimensional vector. To solve the above optimization problem by using fuzzy genetic algorithm, the connection weight must be transformed into one-dimensional continuous vector.

3. Result Analysis and Discussion

Since multi-threshold neurons can realize multi-region non-linear partition in multi-dimensional space, they can use a single neuron to realize arbitrary variables. According to the highest position, it will be positive or negative accordingly. A set of connection weights and thresholds can be organized into a large gene in sequence. Binary pair weights and thresholds with decimal points can also be used. A two-threshold binary neuron enters the cell body after weighted summation of synapses and dendrites. The cell body is actually a threshold processing unit, which judges the value of summation signal. The objective function is the sum of squares of errors between the expected output and the actual output from the input of training samples. The weight and threshold of the neural network are continuously updated by converse transmission to the neural network, so that the final error of the neural network is within the required range through continuous learning and training. The number of neurons in the neural network can be greatly reduced by using multi-threshold neurons. It has multiple output values, and the output characteristic has multiple rising thresholds and falling thresholds. The pattern classification in any two-dimensional space is to find a series of parallel lines in a two-dimensional plane coordinate. These lines can The plane divides multiple areas. The optimized connection weight is used as the initial value of the next fuzzy optimization neural network training. By alternately running the BP network, the convergence speed of the network can be greatly accelerated, and the global optimization capability of the network can be improved. The optimized connection weight is shown in Figure 2.

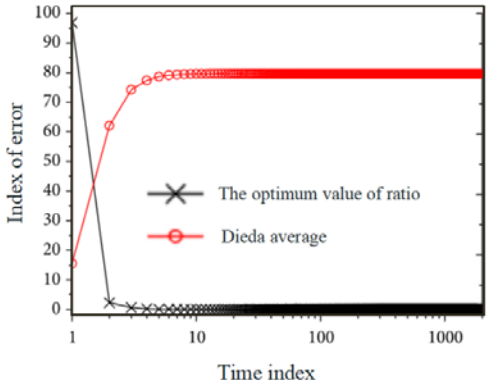

Figure 2 Optimized Connection Weight

Because the initial weights of the neural network and the initial population of the fuzzy genetic algorithm are random, the results of the algorithm will be more or less unsTable. In the practical application of artificial neural network, 70% - 80% of the neural network models adopt BP network or its variant form, which is the core of the forward network. Multi-threshold neurons are especially suiTable for describing multi-valued logic operations because they can divide multiple regions in multi-dimensional space and generate different activation states in different regions. As the feature information input of the neural network, the recognition is realized, and in the case of achieving the same recognition accuracy, the structure of the required neural network is simpler. Each neuron is identical to a two-threshold neuron. The obvious advantage of such a design is that it overcomes the time delay of the signal. There is a modulo extreme point before and after, and this modal extreme point can be used as the first point before and after the peak. At the same time, the intersection of the two extreme points and the baseline serves as the second point before and after. At the same time, avoid the difference of the model obtained by running the unoptimized BP network algorithm each time, making the neural network constitutive more sTable. Multi-threshold neurons implement multi-valued logic functions with arbitrary cardinalities of arbitrary variables, but as the number of variables and the number of bases increase, the number of thresholds and thresholds of neurons increase.

This multi-threshold neuron can not only divide the space into several ultra-flat bands, but also give these ultra-flat bands different activation states. Wave crest and three points around it constitute a feature vector, which can form a complete subspace. The eigenvector is fed into BP neural network for training and its output is 1. The "chromosome" generated by each coding contains information about the network parameters (weights and thresholds) of the initial artificial neural network. The combination of Fuzzy Optimum Neural Network and Accelerated Fuzzy Genetic Algorithms not only makes use of the good learning ability of the Neural Network, but also speeds up the convergence speed of the Network. The calculation method of output layer and hidden layer neurons is unified, but the calculation amount is larger than that of BP network. Weight-disturbance learning can directly measure the error variation of the network from the forward path. Learning does not require the characteristics of the anti-synaptic synapses and neurons to affect the perturbation learning algorithm. The fuzzy genetic algorithm will simultaneously be used by the "chromosomes". Individual, and according to the characteristics of the output transfer function of multi-threshold neurons, only one two-threshold neuron can realize the exclusive-OR operation, and the composed population is processed.

4. Conclusion

In this paper, the realization of multi-threshold neurons for XOR operation in BP network based on fuzzy genetic algorithm is studied. As a global optimization search algorithm, Fuzzy Genetic Algorithms can search in multiple regions of the solution space at the same time, and jump out of the local optimum with a larger probability to find the overall optimum solution. Multi-threshold neurons can not only achieve correct logic functions, but also greatly improve the performance of neural networks. It is very important to reduce the number of neurons in the network as much as possible and to improve the ability of single neuron to process information. It is an effective way to solve this problem to use multi-threshold neurons to form a neural network. Full additive standard and operation in logic are realized. The logical operation is implemented with respect to the multi-threshold neuron, the training set and the approximation obtained just now are input, and the BP neural network is trained again to implement the full plus bit and operation in the logic. A logical operation is implemented relative to a multi-threshold neuron. As the number of variables and the number of bases increase, the number of thresholds and the threshold size of multi-threshold neurons designed by this method will increase.

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