

Research on BP Neural Network Prediction Model Based on Genetic Algorithms

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Abstract: On the basis of BP neural network model, genetic algorithm is introduced, and a neural network prediction model incorporating genetic algorithm is proposed, which is the further development of BP neural network model. Therefore, based on BP neural network, the network structure is difficult to determine and the network is easy to fall into local solution problems. The genetic algorithm is used to optimize the connection weight and network structure of the neural network. In the process of genetic evolution, the method of preserving the best individual is adopted to establish a BP network model based on genetic algorithm. The research results show that the prediction ability of BP network model 1 and 2 based on genetic algorithm is improved with the increase of training samples, and the accuracy of forecasting will be improved.

1. Introduction

The BP neural network is an information processing system designed to mimic the structure of the human brain and its functions [1]. With the recovery of neural networks, neural network theory has achieved great success and progress in many research fields such as pattern recognition, automatic control, signal processing, assisted decision making, and artificial intelligence for nearly 20 years [2]. The physical meaning of the excitation function is clear and intuitive [3]. Genetic algorithm is an adaptive global optimization probability search algorithm that simulates the genetic evolution process of living things in the natural environment. It has the advantages of simple universality, robustness and suitable for parallel processing [4]. A three-layer BP neural network can approximate any non-linear function with arbitrary accuracy. Forecasting is an indispensable and important basic work in national economic construction. For example, North China is densely populated and economically developed, but frequent drought disasters and serious shortage of water resources are the main natural factors that restrict the economic development of North China [5]. However, in practical applications, BP neural network also exposes some of its own weaknesses, such as slow convergence speed, easy to fall into local extreme point [6]. In addition, the initial connection weight of the neural network and the selection of the network structure are lack of basis and have great randomness. It is difficult to select the global initial point, so the possibility of finding the global optimum is small, which limits its application in the actual weather forecast.

A large number of simulation experiments and theoretical studies have proved that BP algorithm is an effective neural network learning algorithm. It has a strong ability to deal with non-linear problems. In recent years, it has been widely used in medium and long-term weather forecasting [7]. BP neural network has become one of the most widely used models, and has been widely used in various fields, such as pattern recognition, function approximation and image processing [8]. How to combine fuzzy set theory, neural network and genetic algorithm organically can not only express people's knowledge and experience with fuzzy concept, but also make use of the strong learning ability of neural network [9]. It can also combine the characteristics of global search of genetic algorithms, and work in this area is still rare. Research on the mechanism of intelligent characteristic processes such as learning, association and memory and its simulation are receiving more and more attention. At present, genetic algorithms have been successfully applied to function optimization, combinatorial optimization, production scheduling problems, machine learning, data mining, etc., so genetic algorithm is an important optimization algorithm [10]. In order to overcome the above problems, many optimization algorithms are introduced into the learning of neural network weights and the automatic design of structures, such as the construction of neural networks

based on particle swarm optimization algorithms. Both traditional methods of forecasting, such as genetic analysis and statistical methods, and new methods such as fuzzy analysis, artificial neural networks, geographic information systems, and gray system analysis have made gratifying new developments.

2. Introduction to genetic algorithms

Genetic algorithms originate from computer simulation studies of biological systems. As early as the last century, some scholars began to study how to use computer for bio-simulation technology. They carried out research on biological evolution process simulation and genetic process simulation from the biological point of view. Since the genetic algorithm can search for the global optimal solution and the robustness of the genetic algorithm is strong, it is meaningful to combine the genetic algorithm with the feed forward network. Not only can the generalized mapping capabilities of neural networks be exploited. Moreover, the neural network has a fast convergence and a strong learning ability. After entering the age, professors and their students at the University of Michigan in the United States were inspired by this simulation technique to create an adaptive probability optimization technique based on biological genetics and evolutionary mechanisms suitable for complex system optimization calculations, genetic algorithms. The main characteristics of genetic algorithm are the strategy of group search and the information exchange between individuals in the group, and the search does not depend on gradient information. It can be widely used in combinatorial optimization, machine learning, adaptive control, planning and design, artificial life and other scientific fields. The genetic operation includes three parts: selection, crossover and mutation. Selection is to select good individuals from the population according to their fitness, and then inherit them to the next generation. Then crossover and mutation are applied to the population to further realize the evolution of the population.

Five times in a row, after 30,000 times of training, the final accuracy is only 0.107. The corresponding test results are shown in Table 1.

Table 1 Prediction test results using BP algorithm alone

Sample number	Forecast value	Measured value	Relative error (%)
1	389.4	405	2.761
2	395.2	361	18.256
3	384.5	313	23.942

The genetic algorithm was first proposed by foreign scholars in the 1970s. Its main characteristics are the group search strategy and the information exchange between individuals in the group. The search does not depend on gradient information, nor does it need to solve the function differentially. It only needs the function to be solvable under constraints. After more than 30 years of development, the theoretical research and application of genetic algorithm have achieved fruitful results in many fields. Especially in recent years, the worldwide boom of evolutionary computing, intelligent computing has become an important research direction of many applied disciplines. Different selection rates can be used at different stages of genetic algorithm implementation, which will help to prevent premature phenomena of genetic algorithm, thus creating the concept of adaptive genetic algorithm. As a global optimization search algorithm, genetic algorithm is widely used in different fields because it is simple, universal, robust and suitable for parallel processing. It is impossible and unrealistic to find the optimal solution completely accurately in these complicated situations. Therefore, it is one of the main points of attention to find the approximate optimal solution or satisfactory solution. The genetic algorithm is to solve such problems. Provides effective ways and methods. The genetic algorithm is a group-based operation algorithm. After encoding the solution space vector, it is necessary to randomly generate chromosomes to form the initial population of the genetic algorithm, and then start the iterative search with this initial group as the starting point.

The results of both GA and BP algorithms are sensitive to the algorithm parameters used in the training process. The results of BP algorithm also depend on the initial state of the network.

However, BP algorithm is more effective when used for local search, and GA is good at global search. The evolution of neural network connection rights is the evolution of connection rights under the premise that the network structure has been determined, and the neural network structure design is very important in neural network applications, because the structure of a neural network reflects the information processing capability of this neural network. The number of nodes of the input layer and the output layer of the actually applied network is determined. Therefore, how to determine the number of hidden layer nodes becomes an important technical issue of interest. The combination of Fuzzy Optimum Neural Network and Accelerated Genetic Algorithms accelerates the convergence speed of the network while utilizing the good learning ability of the neural network. In the practical application, the hybrid forecasting algorithm is not only accurate, but also fast and stable in the application of annual runoff forecasting at Yamadu Station. When genetic algorithm is used to optimize computation, the amount of computation is large. When the large-scale neural network is designed to solve complex problems, the number of connection weights increases sharply with the increase of the number of neurons, which results in a large search space for genetic algorithm.

3. BP Neural Network Prediction Model Based on Genetic Algorithms

The connection weight of BP neural network mainly affects the performance of the network. It is obtained by giving a set of initial weights and gradually adjusting them in training, and finally a better weight distribution is obtained. Alleles can be a set of integers, a range of real values, or a pure marker, depending on how they are encoded. When forward propagation occurs, the direction of propagation is from input layer to hidden layer and then to output layer. The state of each layer of neurons only affects the next layer of neurons. If the desired output is not obtained in the output layer, the back propagation process of error signals is turned. Using genetic algorithm to optimize the connection weights of fuzzy optimal neural networks is to code the connection weights of fuzzy optimal neural networks, form chromosomes, and then simulate the evolution process of nature. The error function of BP network is square, which has the problem of local minimum, and the convergence speed is slow. The genetic algorithm GA has global search ability, and has unique advantages in searching for complex problems and nonlinear problems, but it is far less in learning and training than neural networks. The basic idea is that when the convergence speed is slow in the fuzzy optimal neural network training, the algorithm is transferred to RAGA to optimize the connection weight of the network. The application of neural networks has penetrated into various fields and achieved remarkable results. Neural network theory has also become an emerging, integrated, cutting-edge discipline involving multiple disciplines.

It can be seen from the results in Table 2 that under the condition that the modeling samples are the same and the forecasting factors are the same, the BP network model based on genetic algorithm has better prediction accuracy than the stepwise regression model for the independent samples of this year, and the forecast results are stable.

Table 2 Two forecasting models of forecasting factors for independent sample forecast results in recent years

Years	Live situation	Step by step		BP network based on genetic algorithm	
		Forecast	Relative error	Forecast	Relative error
2013	212.6	126.33	16.36	203.65	5.69
2014	284.4	124.67	13.45	254.36	11.67
2015	265.3	11.59	25.67	245.37	12.32
2016	241.4	128.35	26.35	213.95	14.82
2017	233.9	126.14	21.75	216.47	11.91
20118	274.1	119.36	25.22	249.36	12.67

Each neuron is determined by its input, activation function, and threshold. The optimized connection weight is used as the initial value of the next fuzzy optimization neural network training. The genetic algorithm begins with a population that represents a potential set of problems that are composed of a certain number of individuals genetically encoded. Moreover, due to the use of local time series modeling, good forecast results can also be obtained. Therefore, the local past time process is also an important factor when making predictions. It is the first problem to be dealt with in solving practical problems by genetic algorithm, and it is also a key step in designing genetic algorithm. However, up to now, there is not a set of rigorous and complete guiding theory and evaluation criteria to help us design coding scheme. However, the selection of initial points is blind, and it is difficult to select the global initial points. In addition, the solving space of practical problems is often its complex multi-dimensional surface, and there are many local extremum points, which makes the possibility of BP algorithm falling into local extremum points increased. By running the BP algorithm and RAGA alternately, the convergence speed of the network can be greatly accelerated, and the global optimization ability of the network can be improved. BP Neural Network fully draws lessons from the theory of biological evolution in nature, the survival of the fittest and the survival of the fittest. After generation selection, cross-recombination and mutation, the population gradually tends to balance, that is, some characteristics have comparative advantages.

4. Conclusion

Genetic algorithm optimization of neural network mainly includes three aspects: optimizing network structure, optimizing weight coefficients and optimizing network structure and learning rules at the same time. In flat areas, this phenomenon is more obvious. As a global optimization search algorithm, genetic algorithm can search in multiple areas of solution space at the same time. And it can jump out of the local optimum with a larger probability to find the global optimum solution, thus greatly speeding up the convergence speed of the network. Combining neural network with genetic algorithm, a scheme of global optimization of weights and topological structure of neural network using genetic algorithm is given, and applied to practical cases. The randomness of the initial weight of the neural network and the network oscillation caused by the network structure determination process are solved. And the problem of easy to fall into the local solution. The example calculation shows that this new method avoids the difficulty of the general neural network relying on experience to determine the network structure. And under the same conditions of modeling samples and forecasting factors, the forecasting effect is obviously better than the stepwise regression model, and the forecasting results are stable, which has certain universal applicability. The BP algorithm has strong local search ability. When GA optimizes the network globally to a certain extent, it uses BP to fine-tune it, which greatly increases the convergence speed of the network and reduces the occurrence of training failure.

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