Design of Improved Genetic and BP Hybrid Algorithm and Neural Network Economic Early Warning System

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Abstract. This paper analyzes some key problems in the design of neural network economic alarm system, and puts forward an improved Liao Chuan algorithm. On this basis, it introduces a hybrid algorithm neural network economic prediction system based on the improved genetic algorithm and BP algorithm. In order to optimize BP neural network comprehensively and make it have better generalization performance, a genetic algorithm is improved and designed. The comparison test shows that the improved genetic algorithm reduces the memory consumption, ensures the diversity of population, and improves the running speed and convergence effect of the algorithm.

Keywords: Early warning · BP algorithm · Genetic algorithm · Neural network

1 Introduction

Artificial neural network is a mathematical model, which has some characteristics of human neural network and the ability of self-learning. The training model can be used to solve the same type of problems. The wrong signal output sample and network outlet will be adjusted according to the weight and threshold before connecting the path channel, while the error signal will describe the method of using the general gradient descent method to calculate the reverse connection to adjust the restoration.

BP neural network has the ability of nonlinear mapping, which essentially realizes the mapping function from input to output. Mathematical theory proves that the three-layer neural network can approach any nonlinear continuous function with any accuracy. The convergence speed of BP neural network algorithm is slow: because BP neural network algorithm is essentially a gradient descent method, its optimization objective function is very complex. Because BK algorithm is used to optimize the weighting coefficients of multilayer feedforward neural networks, BT algorithm usually refers to multilayer feedforward neural networks without topology feedback. In the process of learning and propagation, the input signal is input from the input layer, transmitted layer by layer and finally output.

The application of artificial neural networks (ANN) in the early warning (EW) system is a kind of expansion and breakthrough to the traditional EW both in thought and

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technology. It solves the problem that the traditional EW model is difficult to deal with highly nonlinear model, and focuses on quantitative indicators, It is difficult to deal with the warning limits of qualitative indicators. The way to determine the warning limits does not have the characteristics of time-varying, self-adaptive, self-learning ability, indirect acquisition of EW information and knowledge, and low efficiency. Thus, it lays the foundation for the early warning to be realized. Some scholars at home and abroad have also made some theoretical and practical discussions on ANN early warning system, However, due to the professional reasons, they have put into solving several major problems in the design of ANN economic EW system, such as the determination method of ANN economic early warning system network topology structure, the control of convergence speed, the selection of learning factor? And the method of escaping from local minima, etc. Therefore, it is still far from practical application. Based on the experience of Jiaxing Economic EW system, this paper proposes a design method of neural network economic early warning system based on genetic algorithm and BP hybrid algorithm. In other words, the improved genetic algorithm is used to optimize the first three layers of BP network economic electronic system. This paper consists of the following parts. The first part introduces the relevant background and significance of this paper, the second part is the related work of this paper, and the third part is data analysis. The fourth part is example analysis. The fifth part is conclusion.

2 Related Work

The subject of Ref [1] is to provide bibliometric analysis of early warning system, their development and usage in different environment especially in economic and finance sector. Fathani et al. describe the achievements and the current activities of the IPL-158 Project "Development of Community-based Landslide Early Warning System" [2]. Fan et al. introduce the successful landslide early warning system [3]. The subject of Ref [4] is to diminish the deficiency in the strategic cost management and prediction of economic crises. Based on the above background, the aim of Ref [5] is to design an economic early warning system based on improved genetic and BP hybrid algorithm and neural network. Bazhenova et al. deal with the early warning system that allows monitoring the external sustainability of an economy due to external economic shocks [6]. The contribution of Ref [7] is to provide a complex embedded system analysis of early warning systems and their development and use in a variety of environments, especially in the economic and financial fields. The development of an Internet of Things (IoT) technology based Intelligent Tracking, Early-warning & Management (ITEM) tool is elaborated, which is used to track the route of the tanker and temperature of the milk [8]. This work is concerned with the development of an early warning system that can act as a predictive tool for public health preparedness and response [9].

In the first mock exam, the economic EW is a pattern classification process: from the mapping relationship between the mega index to the alert index and the alert degree, the economic EW is a function approximation process. From the voice alarm and the alarm accuracy processing mode from the mega index to the universal index to the alarm degree, the economic EW is also an optimization process. Pattern recognition, function approximation and optimization are the application fields of ANN. Therefore, Ann is very suitable for economic EW.

Genetic algorithm is a global probability search algorithm based on natural selection and genetic mutation. Like the derivative based analytical method and other heuristic search methods (such as mountain climbing, simulated annealing, etc.), genetic algorithm is a formal iterative method. It starts from the selected initial solution and improves the current solution through continuous iteration until the optimal solution or satisfactory solution is finally found. In evolutionary computation, the evolutionary mechanism of simulated organisms is adopted in the iterative calculation process. Starting from a group of solutions (population), the population with better performance index is generated by adopting the method similar to natural selection and sexual reproduction and inheriting the original excellent genes.

2.1 Brief Introduction of Forward Three Layer BP Network Economic EW System

Artificial neural network is the most widely used three-layer BP network composed of input layer, hidden layer and output layer. The hidden layer is located between the read layer and the write layer used for internal display in the read mode.That is to say, it extracts the features which are different from other types of input patterns in a class of input patterns, and transmits the extracted features to the output layer. The output layer makes the final judgment on the categories of input patterns, so the hidden layer is regarded as the feature extraction layer. The process of feature extraction in hidden layer is actually the process of "self-organizing" the connection weight between input layer and hidden layer. In the process of network training, the connection weight between the layers plays the role of "transfer characteristics". The process of gradual evolution from the initial mode to the random representation is the process of the organization's self representation.

The exponential EW method is the basis of other traditional EW methods. This is also the most commonly used electronic warfare method. Obviously, EW system is very suitable for selecting three-layer forward BP network.

2.2 Determination of Network Topology of Forward Three Layer BP Network Economic EW System

The number of nodes in the input layer depends on the number of warning indicators. The number of output layer nodes is determined by the number of alarm stages (for example, the alarm stage is divided into 5 stages, and the number of light, medium, light and no alarm output layer nodes is 5).

On the basis of a large number of experiments and the application examples of three-layer BP network at home and abroad, we get the empirical formula of the upper limit of the hidden node.

$$l_h \leq \sqrt{m(n+3)} + 1 \tag{1}$$

(M is the number of input layers and N is the number of output layers).

Therefore, the lower limit of hidden nodes can be defined as the number of types of warning indexes.

New research shows that artificial intelligence network based on human brain can effectively perform cognitive tasks. The research team examined MRI data through a large open scientific database, reconstructed the brain connection mode and applied it to the artificial neural network "NN". The research team hopes to combine brain connectivity histology with related ATL structures, understand how brain structures support specific cognitive functions, and introduce new design principles into artificial networks.

Ducks can swim soon after hatching. Human babies will naturally be attracted by human faces. Even if the brain evolves to the point where it dares to face the world with little experience, many researchers hope that AI also has this natural ability.

New research has found that artificial neural networks can evolve to the extent that they can perform tasks without learning.

Such networks usually learn many tasks by adjusting the "weight" or strength of connections between neurons, such as playing games or recognizing images. The network is mutated by adding neurons, increasing the connection or changing the sensitivity of neurons to the sum of inputs. After gradually improving the weight of the standard network architecture, you can skillfully complete these three simulation tasks: driving the car, making the biped robot walk and controlling the two wheeled cart to balance the strut.

For example, he has amazing insight and observation ability in external affairs, is good at thinking and research, and dares to explore. Psychology and computer are his strengths. At the same time, he has made great achievements in the field of artificial intelligence neural network, which is also known as the "father of neural network".

In 1960, Michael mett and Papert, the "father of artificial intelligence", published an article pointing out that the composition of the concept of neural network is too simple and can only be used to solve current problems.

Based on the research results of medicine and psychology, he decided to use computer science methods to simulate the brain and continue to explore the direction of neural network. He is committed to using artificial neural networks to simulate human brain storage and thinking. Although the academic circles thought the problem was unrealistic at that time, Geoffrey chuon and his colleagues still made some achievements in such a harsh environment in the 1980s when computer computing was slow and data could only be processed in small batches. A year later, they improved the model and made challenging suggestions to limit the Boltzmann machine. In the following years, Geoffrey Hinon and his team NCAP gradually realized some ideas of early neural network research due to the great improvement of computer computing and data processing ability.

2.3 A Method to Determine Whether Hidden Nodes are Redundant

For the network with $m \times l \times n$ topology, after N training samples, the output matrix Z of hidden layer is as follows:

$$Z = \begin{pmatrix} Z_{11} & Z_{21} & \cdots & Z_{41} \\ Z_{12} & Z_{22} & \cdots & Z_{42} \\ & & \vdots & \\ Z_{1N} & Z_{2N} & \ldots & Z_{3N} \end{pmatrix} \tag{2}$$

When new China was founded, in many newly liberated cities, the influence of hyperinflation during the Kuomintang rule continued. From July 27 to August 15, the central finance committee held a financial conference in Shanghai and decided to take measures such as issuing bonds to strengthen the strength of the state-owned economy in the market struggle. A large number of illegal speculators took the opportunity to rise a storm, and many big price fluctuations continued to appear in the market, leading to social unrest. Establish and consolidate a new political power and maintain economic and social stability? People don't trust the RMB. They rush to buy silver, gold and foreign currencies as soon as there is a disturbance, which hinders the RMB from occupying the market and stimulates the price rise. Does the people's government led by the Communist Party have the ability to stabilize the economic situation, stop hyperinflation and restore production, and make the new regime stand firm economically and politically?

The outline points out that since the people's revolutionary war is winning nationwide, in order to restore and develop the national economy as quickly and systematically as possible, and make use of the current needs to supply the people's revolution. For the purpose of war and improving life, we should establish central financial and economic institutions with working ability, so that the financial and economic system of local governments and the committees of people's governments at all levels have established some financial and economic departments, and many financial and economic institutions have been established under the leadership of the central and higher financial and economic organs.

While preparing for the establishment of the central finance committee, the Party Central Committee also began to consider and deal with the national financial and economic problems, strive to stabilize prices and establish RMB as the only currency. In the face of the acts of speculators and ourselves, and against the rampant actions of the new regime to maintain economic stability, the East China Bureau of the CPC Central Committee decisively decided to take base salary measures and begin to seal up the concentration point of the financial speculative market. Finally, the instructions of the CPC Central Committee on cracking down on banks and the occupation of seats by RMB were issued. On June 8, the instructions of the East China Bureau and the Shanghai municipal Party committee put forward a series of economic measures, including explicitly requiring railway transportation and municipal utilities to accept the opening of RMB and the exchange between each release zone.

On behalf of the central government, Chen yundai drafted the telephone newspaper of the East China Finance Committee and decided to first attack the power of speculation in Shanghai with severe means. Seeing that the government did not sell materials, the speculative forces firmly believed that the Communist Party did not have enough material strength to compete with them. At the same time, the people's Government pressed for taxes, tightened the root causes of banks, frozen loans and marched on speculators. Speculators suffered from the enemy and went bankrupt. Only more than ten days later, the people's government won a fruitful victory, and the capital of illegal speculation came from here.

3 Data Analysis

3.1 Introduction of Genetic Algorithm

The main characteristics of genetic algorithms (GAs) are simple data processing, strong robustness and giant parallel computing. Its essence is a cyclic process composed of four operators: reproduction, exchange, mutation and selection. GAs does not need any gradient information and does not need any calculus calculation in the process of searching for the global optimum. Only through the above four operators, the global optimal or suboptimal solution can be found in the solution space with great probability, thus effectively reducing the probability of falling into the local minimum. From the ability to find the global optimal solution, gas is far superior to simulated annealing algorithm, and is an ideal tool to improve the forward three-layer BP network. The introduction of genetic algorithm is shown in Fig. 1.

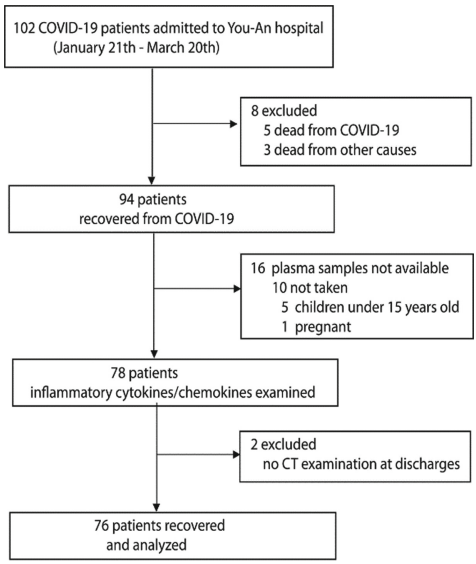

Fig. 1. Introduction of genetic algorithm

The degree of individual population can be defined by the generalized Hamming distance between individuals. For the individual coding in this paper, the generalized Hamming distance between individuals is defined as follows:

$$H_X = (X_i, X_j) = \frac{1}{(2n+1)} \sum_{x=1}^{2n+1} H_G(G_i{}^x, G_j{}^x) \tag{3}$$

3.2 Basic Idea and Concrete Method of Accelerating GAs Convergence Rate

Suppose an individual is composed of two chromosomes. After several cycles of reproduction, exchange, variation and selection, the value of one chromosome becomes the ideal value, while the value of the other chromosome deviates from the ideal value. According to the individual fitness of conventional GAs, this individual should be eliminated from the sea. If we don't take the individual as the research object, but take the chromosome of the individual as the research object, we can carry out the reproduction, selection, exchange and laughing operation of the individual chromosome one by one in order to find and save the chromosome that can improve the individual fitness, so as to avoid the phenomenon of abandoning the single chromosome which improves the individual fitness, The convergence rate of GAs can be greatly accelerated.

The network error of BP neural network model is in the form of mean square error, and the complexity of network structure is expressed by the number of nodes that can be connected between layers. In order to optimize the weight and structure of the network at the same time, the number of fitness networks is designed as follows:

$$f(i,t) = \frac{\lambda}{1 + E_1(i,t) + \beta E_2(i,t)} + \frac{(1-\lambda)}{T(i,t)} \tag{4}$$

GAs regards a weight a of a forward three-layer BP network as a chromosome, and regards the set of all weights in the network as an individual: a large number of individuals are generated in the initialization stage, and some individuals with higher fitness are selected as parents according to the fitness of each individual, According to the probability, select two individuals for exchange operation to generate two offspring, or select an individual for mutation operation to generate one offspring. When the adaptability of all individuals in an individual is almost the same, it is transferred to the first three layers of BP network. At the end of the current three-layer BP network, the mean square error of the network can not meet the accuracy requirements. At this time, it may be reduced to the local minimum. Therefore, it is transferred to gas and a new whole is generated based on the volume at this time. Repeat the above steps until the balance root error of the network meets the accuracy requirements.

4 Example Analysis

On August 18, Sichuan disaster reduction center, emergency command center of Sichuan emergency management department, Wenchuan County People's government and Chengdu Institute of high tech disaster reduction jointly announced that the multi disaster early warning demonstration project in Wenchuan has been started.

According to the Wenchuan earthquake early warning network built in 2012, relying on the implementation of multi disaster early warning demonstration project, Wenchuan will establish nearly 30 data sources covering "sky and underground", covering earthquakes and other diseases. The system is interconnected with the disaster early warning network of surrounding cities and counties, and transmits warning information to the people, emergency departments and towns through comprehensive research and judgment in the affected areas of Wenchuan province.

$$u_{k+1}(t) = u_k(t) + L(t)(\dot{e}_{k+1}(t) + e_{k+1}(t)) \tag{5}$$

$$\sup_{0\le t\le T} \|I - L(t)C(t)P^{-1}(t)B(t)\| \le \rho_1 < 1 \tag{6}$$

It is reported that the Institute and Sichuan disaster reduction center jointly take the lead in technical coordination. At the same time, the early warning system will also synchronize disaster information to the city and county emergency management command platform, realize the connection between disaster early warning and emergency management, and provide emergency command. On the basis of the earthquake early warning network built in 2010, the multi disaster warning project was launched in September this year, covering 51 multi disaster early warning and monitoring points. The launch of the project will certainly promote the disaster early warning work throughout the province, better provide strong support for basic public services in Sichuan, further improve the technical service capacity of disaster prevention and reduction, improve the level of disaster prevention and reduction, promote the upgrading of disaster prevention and reduction industry, and help Sichuan's economic and social development and safe development. Through cooperation with Chengdu High Tech Institute of disaster reduction in technology and application, a multi disaster, all region and all channel natural disaster early warning service system has been established in Wenchuan County, which has comprehensively improved the modernization level of earthquake prevention and control capacity. Including 63 destructive earthquakes and 180 cases of landslides, debris flows, mountain torrents, wildfires and other Wenchuan multi disaster early warning demonstration projects, marking the first time that "Sichuan intelligent manufacturing" has fully applied the multi disaster early warning results within the county.

Xian Sheng, deputy director of Sichuan disaster reduction center, said that the launch of the Wenchuan multi disaster early warning demonstration county project will take the lead in promoting disaster relief and early warning in Sichuan into a basic public service. "Multi disaster early warning is a natural extension of earthquake warning, from a single natural disaster to a response to multiple disasters. Before that, we carried out some experiments, tests and preliminary services of catastrophic operation technology in Chengdu. The project has coordinated with more than 15 departments in Wenchuan County, realizing a better linkage between disaster early warning information and government departments, so as to better serve the people Wenchuan city serves". Wang Yi, director of Chengdu multi disaster early warning engineering technology research center and director of Chengdu Hi Tech Institute of disaster reduction, said that the multi-party linkage of the project will build a disaster early warning system. Example analysis is shown in Fig. 2.

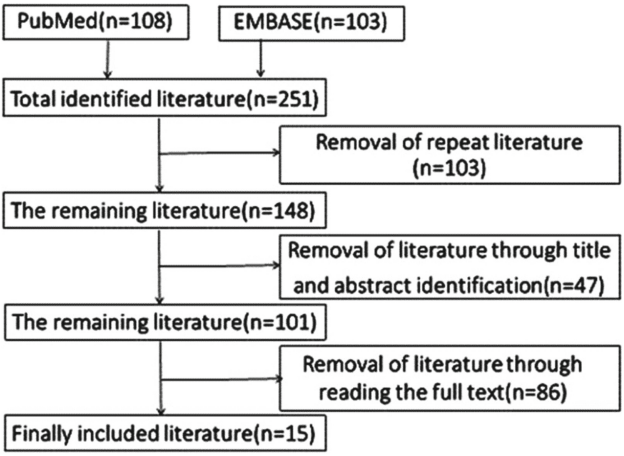

Fig. 2. Example analysis

5 Conclusion

The improved back application which reduces the population size to the minimum can greatly reduce the memory consumption of genetic algorithm and improve the running speed. As a special evolutionary operator, BP algorithm can adjust the network weight and change the network structure according to the knowledge of the leading city. The introduction of generalized Hamming distance between individuals can ensure the diversity of the population; BP operator, mutation operator and crossover operator compete together to adapt to adjust the operation probability and promote the convergence of the algorithm. Compared with BP algorithm and hybrid genetic algorithm, this algorithm can optimize the network structure, make it have better generalization performance, effectively ensure the diversity of population, improve the running speed and convergence effect of the algorithm, which is stable and reliable; moreover, compared with BP algorithm and hybrid genetic algorithm, this algorithm has smaller internal storage and faster running and convergence speed than BP algorithm and hybrid genetic algorithm.

References

1. Klopotan, I., Zoroja, J., Meško, M.: Early warning system in business, finance, and economics. Int. J. Eng. Bus. Manage. **63**(3), 581–592 (2018)
2. Fathani, T.F., Karnawati, D.: TXT-tool 2.062-1.1: a landslide monitoring and early warning system. J. Syst. Manage. **32**(17), 13233–13244 (2018)
3. Fan, X., et al.: Successive landsliding and damming of The Jinsha River in Eastern Tibet, China: prime investigation, early warning, and emergency response. Landslides **179**(6), 764–774 (2019)
4. Ayvaz, E., Kaplan, K., Kuncan, M.: An integrated LSTM neural networks approach to sustainable balanced scorecard-based early warning system. IEEE Access **173**, 150–162 (2020)
5. Yin, X., Li, J., Huang, S.: The improved genetic and BP hybrid algorithm and neural network economic early warning system. Neural Comput. Appl. **169**(9), 1133–1139 (2021)

6. Bazhenova, O., Chornodid, I., Yarmolenko, Y., Golubev, O.: Early warning system of external sustainability of an economy: case of Ukraine. Financ. Credit Act. Probl. Theory Pract. **27**(9), 2610–2626 (2021)
7. Lin, J.: Design of enterprise financial early warning model based on complex embedded system. J. Syst. Sci. **10**(6), 363–377 (2021)
8. Avhale, G.V., Shaligram, A.D., Gharpure, D.C.: IoT based intelligent tracking, early-warning & management (ITEM) tool for efficient milk transportation in dairy industry. J. Syst. Design Dyn. Dev. **8**(3–4), 279–292 (2021)
9. Pergantas, P., et al.: Towards a semi-automatic early warning system for vector-borne diseases. Int. J. Environ. Res. Public Health **30**(4), 377–399 (2021)