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Research on the Coupling between Rural Industrial Structure and Economic Development in the Yangtze River Economic Belt Based on the Coupling Coordination Degree Model

Yahao Deng[1,*]
[1] School of Finance and Management, Chongqing Business Vocational College, Chongqing, 401331, China
Corresponding authors: (e-mail: dyhdyh1006@163.com).

Abstract Public crises are a significant area of research, drawing attention from scholars across diverse fields. Numerous prediction models have been proposed to address real-world challenges associated with crisis events. This study focuses on intelligent prediction models, aiming to predict public crises promptly and mitigate the resultant harm. The paper delves into the application of intelligent computing-based prediction models within the realm of public crisis management. By offering objective data, this research equips decision-makers with valuable information, facilitating the formulation of well-informed plans. The objective is to enhance the decision-making process, introducing scientific rigor and rationality, thereby overcoming the inherent limitations and biases of plans. Experimental results underscore the superiority of the proposed scheme over existing methodologies, showcasing its efficacy in mining crucial information and achieving superior prediction outcomes.

Index Terms internet of things, artificial intelligence, predictive models, intelligent computing, public crisis management

I. Introduction

Prediction is an activity in which the cognitive subject uses the available information and means to reason and judge the future development of things in order to achieve certain purposes. There are certain prerequisites for prediction, namely the reserve of information and the use of means. The quantity and quality of information reserves are closely related to the level of prediction. Relatively speaking, the possession of a large amount of real-time and comprehensive information and data will be more conducive to prediction, and information is the basis and precondition for prediction. Technology and means are the key to transform information and data into judgment, and are important nodes for whether the forecast is scientific or not.

A public crisis is a state in which an event poses a threat to the normal life, work, safety of life and property, and normal social order of the general public in a certain range [1], [2]. Public crises can damage the public interest or threaten the basic values of society, involve a large scope, and generally need to be handled by the public sector. Therefore, in addition to the suddenness, stage, urgency, and harm that general crises have, public crises also have the characteristics of publicness and sociality. Because of the wide range of public crises and their harmful nature, public crisis forecasting has become one of the regular tasks of the public sector. Although individual behavior has variability, group behavior often has predictability, and these predictability are exactly the areas where artificial intelligence and the Internet of Things can play a role [3], [4].

The rapid development of computer technology has brought society into a new era of information technology, and the Internet of Things (IoT) has become an inevitable development trend of the information industry [5]. AI, as the core technology of IoT, replaces human beings to complete work by simulating human thinking patterns and behavioral awareness, which changes the traditional manual production method and is of great significance to improve productivity and people's living standards. IoT, built on the basis and core of AI, has penetrated into various industries and plays an important role in improving the operational efficiency as well as the accuracy of computer systems, and is an important technology to promote social development and progress, and the advantages of the application of IoT with artificial intelligence must be fully utilized. New tools and methods underpin new technological architectures that enable the public sector to build, operate and apply mega-scale data storage and data analysis to create conditions for public crisis prediction.

The country attaches great importance to the construction of emergency mechanisms for sudden public crisis events, and from the perspective of protecting the health of the general public and implementing the people-oriented and comprehensive, coordinated and sustainable scientific concept of development, it is necessary to strengthen the construction of emergency mechanisms for sudden public crisis events from all levels and units, strengthen prevention and emergency preparedness, and need to start from the smallest detail, carry out grid-based real-time data collection, close tracking and monitoring. The use of cutting-edge computer technology and Internet + means to improve health emergency response capabilities and create a new situation for this type of health emergency response is an important part of promoting harmonious social development.

II. Related Work

II. A.Public crisis management

In the 18th and 19th centuries, the term "crisis" entered the political sphere to indicate the emergency situation faced by the government or political system, which led to the concept of crisis management [6], [7]. As for the definition of public crisis, it is generally accepted that a public crisis is a state in which an event poses a threat to the normal life, work, safety of life and property, and the normal social order of the general public [8]. A public crisis is characterized by its suddenness, urgency, danger, stage, and transmission, as well as its public and social nature. Public crises include not only natural disasters and accidents in the traditional security field, but also energy crises, ecological and environmental crises, financial crises, terrorist attacks and other social emergencies in the non-traditional security field.

II. B.Intelligent prediction model

With the rapid development of prediction technology in recent years, various intelligent computational methods such as artificial neural networks and population intelligence have been successfully applied to many prediction fields [9], [10]. [11] explained that there are three aspects of intelligence: biological intelligence, artificial intelligence, and computational intelligence. Where, computational intelligence is realized by mathematical models and computer theoretical algorithms, and the basic computational intelligence technologies include artificial neural networks (ANN) and so on [12].

ANN is a mathematical modeling of the brain's synaptic connection structure, which is often referred to as neural network or neural network-like in engineering and academic circles, and it is widely used in many fields: pattern classification, function approximation and trend prediction [13]-[16]. This model mathematically described the structure of neurons and networks, and proved that a single neuron has the ability to perform logical functions, which started the era of artificial neural network research [17]. Since the 1980s, artificial neural networks have once again entered the research boom [18]. The American physicist Hopfield proposed the Hopfield network model in 1982, which successfully solved the TSP problem (travel quotient problem), and successfully introduced the concept of "computational energy function" into the study of neural networks, and gave the basis for determining the stability of the network [19]. proposed and distributed processing theory, and at the same time proposed the error back propagation learning algorithm for multilayer networks, referred to as BP algorithm has been proven to perform many learning tasks and has been widely used in many fields.

Since prediction is an estimate of the future, it is bound to be different from the objective facts, and this difference is the prediction error. The larger the prediction error, the lower the accuracy; conversely, the higher the accuracy. This shows that the evaluation criteria of prediction performance are necessary. Therefore, this paper combines the idea of designing and developing a prototype knowledge base system for public crisis management cases by using information technology tools such as and so on, and providing various prediction models as a basic service, so as to collect various kinds of public crisis event information and corresponding statistics in a timely and effective way,

III. Methodology

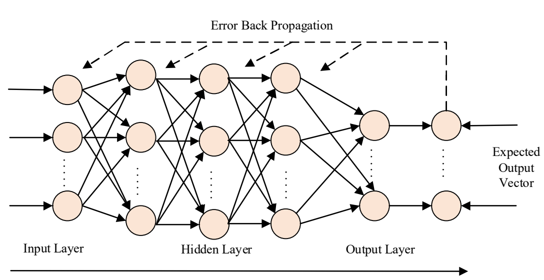

Figure 1: shows the structure of the neural network based on the BP algorithm.

BP artificial neural network is a benchmark algorithm for our research, so the author will focus on describing the specific algorithm process of BP neural network in this chapter. Figure 1 implied the structure of the neural network based on the BP algorithm. BP is a multi-layer feedforward neural network composed of input layer, hidden layer and output layer. If the input dimension and output dimension of the BP network are m and 1 respectively, and the number of hidden layers is P, then the BP mathematical expression of the network is Eq. (1).

$$x_{i+1} = f(X_i) = \frac{1}{1+exp(-\sum_{j=1}^{p} c_j b_j + \varepsilon)} \quad j = 1,2,...,p \tag{1}$$

In the formula, f is the activation function of the hidden layer; ε is the threshold of the output layer; c_j, b_j is the connection weight from the hidden layer to the output layer and the output of the hidden layer node.

Therefore, the output of the hidden layer node of the BP neural network can be expressed as Eq. (2).

$$b_j = \frac{1}{1+exp(-\sum_{i=1}^{m} w_{ij} x_i + \theta_j)} \quad i = 1,2,...,m \tag{2}$$

In the formula, w_{ij} is the connection weight from the input layer to the hidden layer; θ_j is the threshold of the hidden layer node.

Since the prediction result of BP neural network is easily affected by the initial connection weight of c_j, w_{ij} and the threshold of ε, θ_j, and it is easy to fall into the local extreme value problem, so wo should optimize the initial connection weight and threshold of the BP neural network.

The improved BP algorithm with four hidden layer neurons and a learning rate of 0.2 works best. However, it should be noted that it is not easy to generalize the simulation results to all cases because only a few simple samples are used in the simulation and the random initialization of the neural network weights and biases also affects the simulation results. In order to solve some drawbacks of BP networks, people are looking for faster training algorithms on the one hand, and building new network structures on the other. Theoretically, RBF networks can approximate any nonlinear mapping with arbitrary accuracy. It is generally believed that the form of the nonlinear functions used in RBF networks is not important for the network performance, and the key factor is the choice of the center of the basis function. In practice, the centers can be used as some subset of the data, and that subset should be chosen as an appropriate sampling of the input domain. learning of RBF networks can be done using clustering (or other similar methods). After comparison, RBF networks not only have good generalization ability, but also avoid tedious and lengthy computations such as back propagation, and learn 103-104 times faster than the usual BP methods, as shown in Figure 2. However, there is the problem of cluster center selection.

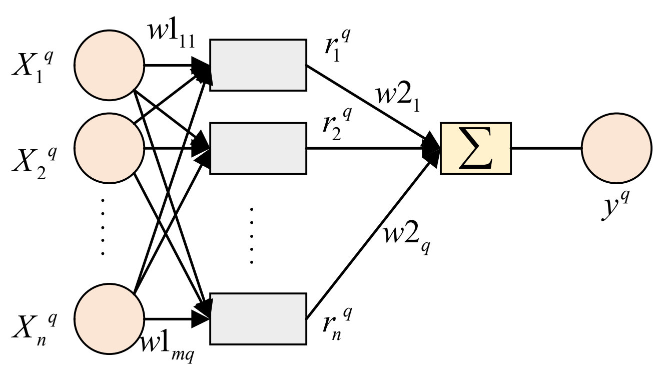

Figure 2: RBF neural network model structure

Feedback neural networks, also known as associative memory networks, aim to eventually converge to a designed equilibrium point by running on their own. There are many kinds of feedback neural networks, and a typical one is the Hopfield network proposed by an American physicist. The applications of Hopfield network are mainly focused on the following fields: image and language processing, data query, fault-tolerant control, pattern classification and recognition, etc. Its structure is shown in Figure 3 and is asymptotically stable. As time passes, the network state moves in a decreasing state, so that if the initial state of the network, its state will not change; otherwise, the network needs to enter a stable equilibrium state. When used for optimization calculations, the network will run cyclically according to the connection weights when the network has an input. When the energy function reaches a minimum, the network is in a stable state, and the learning process of the network is the weight adjustment process.

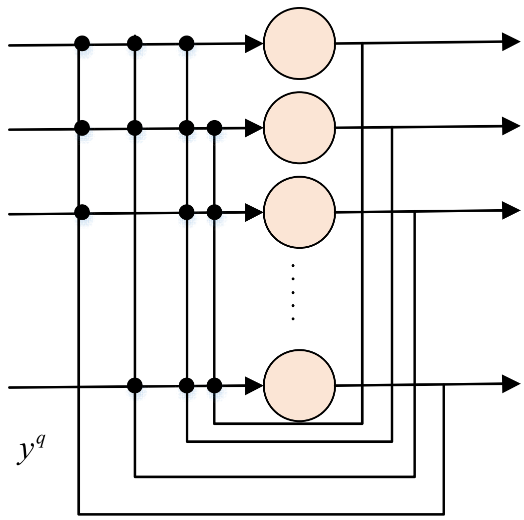

Figure 3: Hopfield network structure

The learning algorithm often used in the Hopfield network is the rule: if the i and j set neurons are in the excited state, then it should be strengthened and increased.

$$\Delta w_{ij} = a y_i y_i \quad a > 0 \tag{3}$$

Assume that the network is required to have p orthogonal steady states $V^s = \left(V_1^s, V_2^s, \cdots, V_n^s\right), s = 1, 2, \cdots, p$ but $w_{ij} = \sum{}^{p}_{s=1} V_i^s V_j^s$.

If a new steady state is added V^{p+1} but $w_{ij} = w_{ij} + V_j^{p+1} V_j^{p+1}$.

Hopfield networks mostly solve constrained design of control systems, and have applications in system identification. The Elman regression model structure is shown in Figure 4.

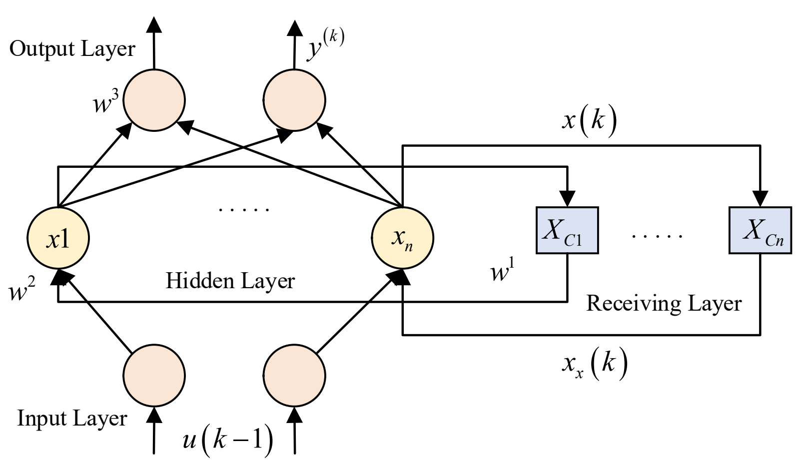

Figure 4: Schematic diagram of Elman regression neural network structure

The Elman method is:

$$\begin{aligned} y(k) &= g\left(w^3 x(k)\right) \\ x(k) &= f\left(w^1 x_c(k) + w^2 u(k-1)\right) \\ x_c(k) &= x(k-1) \end{aligned} \tag{4}$$

$$E(w) = \sum{}^{n}{}_{k-1} \left[y_k(w) - \tilde{y}_k(w)\right]^2 \tag{5}$$

According to the introduction in the previous chapters, the author adopts the standard three-layer network architecture as the research content of this paper an historical data, and m data for predicting the future, which means that there are n historical data to predict m future data. As we all know, the selection of the hidden layer is related to the stability and robustness of the network, so many scholars are engaged in this research. To achieve a better prediction effect, the author adopts the Eight-Nelson method for the selection of layers is determined as $2n+1$. In this way, the network structure used in this paper is determined.

Step 1: Outputs of nodes in the network.

$$\begin{aligned} y_j = f\left(\sum_i w_{ji} x_i + b_j\right) = f\left(\text{ net }_j\right)(i = 1,\cdots,n; \quad j = 1,\cdots,2\text{n}+1) \\ net_j = \sum w_{ij} y_j + b_j \quad (\text{j} = 1,\cdots,2\text{n}+1) \end{aligned} \tag{6}$$

Step 2: Output of the network.

$$O_1 = f_o\left(\sum_j w_{oj} y_j + b_o\right)(j = 1,\cdots,2n+1) \tag{7}$$

Step 3: Use the BP to minimize the error.

The hybrid method can be abbreviated as an algorithm, and the abbreviated form is used below. The specific process of the algorithm is as follows: Steps In order to give the training effect of the model, in terms of data, to avoid the large fluctuation of the original data, it monopolizes the training process of the neural network and cannot reflect the small changes in the measured values. Therefore, before the network training, the author uses the formula (the data are normalized to between, which is convenient to improve the prediction accuracy.

$$X' = \left\{X_i'\right\} = 2 \times \frac{X_i - X_{i\min}}{X_{i\max} - X_{i\min}} - 1, i = 1,2,\ldots,n \quad X' \subset [1,1] \tag{8}$$

Among them, Xin is the smallest value of the data in the original observed, Imax is the largest value to be observed, and X is the observed value.

Step 1: Randomly set a particle swarm, including the position and velocity of the particles.

Step 2: According to the complexity of the data training samples, the data set is relatively simple. Use the current optimal best value of the CPSO algorithm external the network's neurons. MSE represents the mean square error of the entire network.

$$V_i^{l+1} = \omega^t V_i^t + c_1 \tau_1\left(\text{ pbest }^t - x_i^t\right) + c_2 \tau_2\left(\text{ gbest }^t - x_i^t\right) \tag{9}$$

$$X_i^{t+1} = X_i^t + V_i^{t+1} \tag{10}$$

$$D(t) = \frac{1}{N \bullet L} \cdot \sum_{i=1}^{N} \sqrt{\sum_{d=1}^{N}\left(p_{id} - \overline{p_d}\right)^2} \tag{11}$$

$$\sigma^2 = \sum_{i=1}^{N}\left(\frac{f_i - f_{avg}}{f}\right)^2 \tag{12}$$

Step 3: Use equations (9) and (10) to modify the position.

Step 4: Use Equation (11) and Equation (12) to determine whether a chaotic search needs to be performed. If a chaotic search process is required,

Step 5: Modify the parameters and external the selected neurons to the BP neural network for prediction.

Step 6: De-normalize the prediction from between to get the real prediction results.

IV. Experiment

Public crises include not only natural disaster crises, accident disaster crises, etc. from traditional security fields, but also energy crises, ecological environment crises, financial crises, terrorist attack crises and other social emergencies crises from non-traditional security fields. As the basic resource of national economic activities and social production activities, energy is directly related to the country's economic security. In terms of wind energy, while providing clean energy to the power grid, it will also bring some negative impacts. As the installed capacity of wind farms increases and the proportion of wind power installed in a certain region's power grid increases, these negative impacts may become constraints for wind integration. It will reduce the accuracy of power grid load forecasting, thereby the scheduling and mode; affecting the power quality fault level. The power generated by the wind farm is directly related to the local wind speed. Therefore, doing a good job of wind speed prediction can effectively predict the wind energy, thereby reducing the negative impact caused by the connection of the wind farm. In the current study, the wind speed prediction error is generally in the middle range. This section will conduct an experimental study of wind speed prediction. Jaquan area is located between Alton Mountain, Qilian Mountain, and Mazing Mountain (North Mountain) at the western end of Hexi Corridor in the northwest of Gansu Province, and it is the only route for the Silk Road. Jaquan area is about 680. Relying on the abundant wind resources in the region and relying on the Hexi Corridor, Gansu Province has built my country in Jaquan City in recent years—the Gansu Jaquan. It has achieved a total installed capacity of 5.5045 million kilowatts, and generation has up to 2 billion kw. Therefore, Jaquan Base is also called "Three Gorges on Land" in the industry. For Jaquan Wind Farm, the annual utilization of 2300 hours, and the annual power generation of 29.233 billion kWh can reduce smoke and dust by about 130,000 tons, and reduce sulfur dioxide emissions by about 110,000 tons. The carbon dioxide emission is about 2930 tons, and the benefits are obvious. As in the previous introduction, practical significance for wind farms the daily wind speed and hourly wind speed.

Through experiments on the daily wind speed data in Jaquan, we obtained the curve shown in Figure 5. It is not difficult to find that CPSO is set to 1000, and the CPSO algorithm has converged since 300 iterations. Through the experimental results, we found that it is not that the larger set, the higher the prediction accuracy must be. To get a better prediction effect, we traverse in the IS-CPSO-BP from 10 to 300 with a step size of 10. In the experiments we set Train to 50, Trainman to 70, Trained to 5, Dimming to 5, Dima to 15, and Did to 1. See Figure 5.

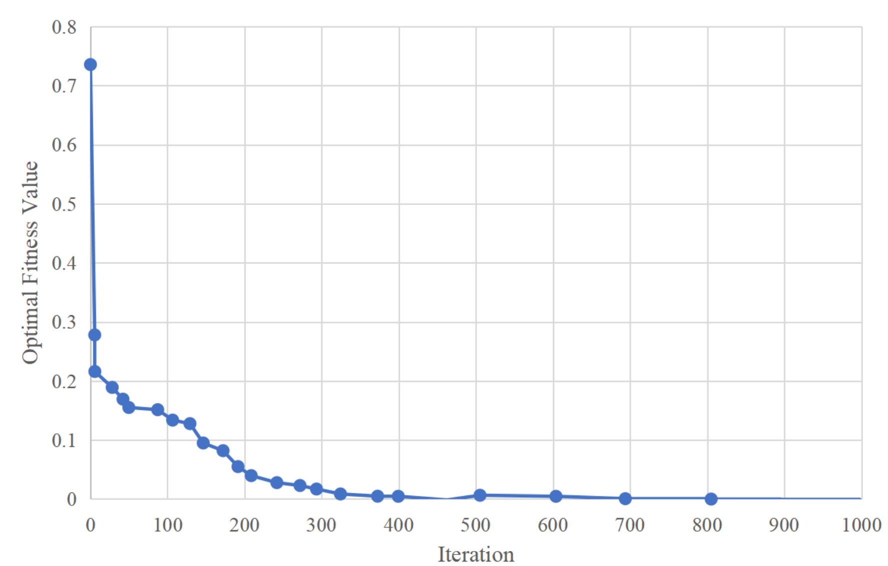

Figure 5: The curve of optimal fitness value of CPSO algorithm

We first use neural networks and models to predict the wind speed in the Jaquan area introduced earlier. For the neural network model, we use the, the speed, and training accuracy. Apply the horizontal data selection method to select training samples, and the obtained prediction simulation results will be given in the table. It should be pointed out that the obtained experimental results are the average results obtained by running each group of experiments separately, and the typical results (and records of for the average, the more important thing is whether the parameter selection is reasonable or not result, when the parameter setting is reasonable neural network model. See Table 1,

Table 1: Results of horizontal data selection method (Jiu Quan daily average wind speed data)

Enter dimension	Number of training samples	Maximum number of iterations	AE	MAE	MSE	MAPE (%)	AE	MAE	MSE	MAPE (%)
			CPSO-BP model				BP model			
5	50	40	0.73	0.93	1.1	27.52	1.13	1.3	2.1	34.63
5	50	290	0.82	1.02	1.53	28.68	1.17	1.25	2	33.37
7	50	50	0.19	0.95	1.65	45.93	0.84	1	1.34	31.62
9	50	190	1.72	1.83	4.15	42.38	1.63	1.72	3.78	41.58
9	50	200	2.22	2.32	5.3	44.78	1.56	1.79	3.96	43.39
14	60	120	0.53	1.09	1.98	87.56	0.62	0.96	1.27	32.33
14	60	130	0.06	1.17	1.97	48.37	0.76	1.08	1.65	33.88
14	65	110	0.31	0.93	1.38	41.93	0.59	0.93	1.18	31.78
14	65	120	0.44	0.95	1.42	37.85	0.59	0.93	1.18	31.82
6	70	180	0.27	0.71	0.81	41.29	0.28	0.76	0.88	29.05
6	70	290	0.27	0.89	1.16	50.36	0.21	0.68	0.68	27.68

We use two different models to predict the wind speed data of Jaquan and use a variety of performance indicators to evaluate the prediction results. Through the IS-CPSO-BP model, we get that when the dimension is 5, the prediction effect of the daily average wind speed data for Jaquan is relatively good. Therefore, the network to 5, adopt the horizontal data selection method, and set the number of training samples to traverse. See Table 2.

Table 2: Results of is CPSO BP and BP methods using horizontal data selection (Jiu Quan daily average wind speed data)

Number of training samples	Maximum number of iterations	AE	MAE	MSE	MAPE (%)	AE	MAE	MSE	MAPE (%)
		CPSO-BP model				BP model			
50	90	0.73	0.96	1.3	27.83	1.17	1.26	2.03	33.36
55	80	0.88	1.06	1.58	28.84	1.1	1.28	2.07	34.19
60	80	0.87	1.06	1.71	28.42	1.25	1.32	2.23	34.06
65	120	0.71	0.91	1.15	26.36	1.23	1.3	2.17	33.78
70	180	0.62	0.87	1.01	26.88	1.21	1.3	2.15	34.01

The prediction accuracy results about the model are given in the table, where each training sample is calculated by the model. Through the experimental results, it is not difficult to see the neural network. The horizontal data selection method is suitable for some situations, but when the sample is sufficient, the vertical data selection method can achieve better prediction effect. The vertical data selection method is applied to select training samples, and the obtained prediction simulation results will be given in the table. The obtained experimental results are the average results obtained by running each group of experiments independently. In the case of random selection of input parameters, the experimental results are like the experimental results under the horizontal data selection method, which is still the model performance. better. See Table 3 - Table 5.

Table 3: Results of CP50-BP model and BP model using vertical data selection method (Jiu Quan daily average wind speed data)

Enter dimension	Number of training samples	Maximum number of iterations	AE	MAE	MSE	MAPE (%)	AE	MAE	MSE	MAPE (%)
			CPSO-BP model				BP model			
5	31	110	-0.04	0.38	0.21	18.76	0.11	0.42	0.25	19.2
5	31	180	-0.01	0.44	0.26	21.93	0.03	0.37	0.19	17.6

6	31	200	-0.32	0.76	1.05	37.59	0.14	0.65	0.58	23.04
6	31	210	-0.2	0.78	1.03	36.17	0.16	0.62	0.54	22.18
9	31	90	0.3	0.87	1.05	33.47	0.68	1.01	1.53	30.7
9	31	110	0.5	1.00	1.47	37	0.53	0.86	1.02	28.55
10	31	220	-0.17	0.83	1.1	39.21	0.46	0.85	1.1	31.53
10	31	240	-0.24	0.86	1.25	44.35	0.57	0.97	1.68	30.32
11	31	250	0.22	0.72	0.73	57.78	0.67	0.77	0.89	32.24
11	31	280	0.27	0.79	0.89	44.56	0.51	0.77	0.84	45.16
13	31	250	0.61	1.61	3.78	47.69	1.46	2.08	6.34	44.6
13	31	260	1.83	2.65	10.14	60.15	1.38	2	5.91	45.3

Table 4: Experimental results of three models using vertical data selection (Jiu Quan daily average wind speed data)

Prediction model	MSE trained	AE	MAE	MSE	MAPE (%)
IS-CPSO-BP	0.46	-0.101	0.09	0.13	5.52
BP	0.12	0.21	0.42	0.23	11.11
ARIMA (1,2,4)	0.32	-0.11	0.38	0.19	8.56

Table 5: Experimental results of three models using vertical data selection methods (Yamen hourly average wind speed data)

Prediction model	MSE trained	AE	MAE	MSE	MAPE (%)
IS-CPSO-BP	2.21	0.16	0.44	2.56	10.11
BP	3.12	1.45	1.52	8.31	24.08
ARIMA (2,2,5)	2.33	-1.58	1.65	8.84	26.17

V. Conclusion

China is currently in a critical period of economic transition and social transformation, which is a period of continuous improvement of the socialist market economy system and rapid economic development, but also prone to the emergence of various social and ecological conflicts such as population, resources and environment, which may lead to various public crisis events. In this context, the use of advanced information technology to build a public crisis management system, the timely and effective collection of various types of public crisis information and the corresponding statistical data, the realization of public information data sharing, on the basis of scientific calculation and evaluation of these data, from which to extract the information hidden in the unknown, can effectively strengthen the prevention and treatment of public crisis events. The current model relies heavily on traversal for parameter selection, and the next section considers the integration of parameter selection and decision trees to achieve fast parameter determination.

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Consent for publication

All authors reviewed the results, approved the final version of the manuscript and agreed to publish it.

Data Availability

The experimental data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declared that they have no conflicts of interest regarding this work.

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