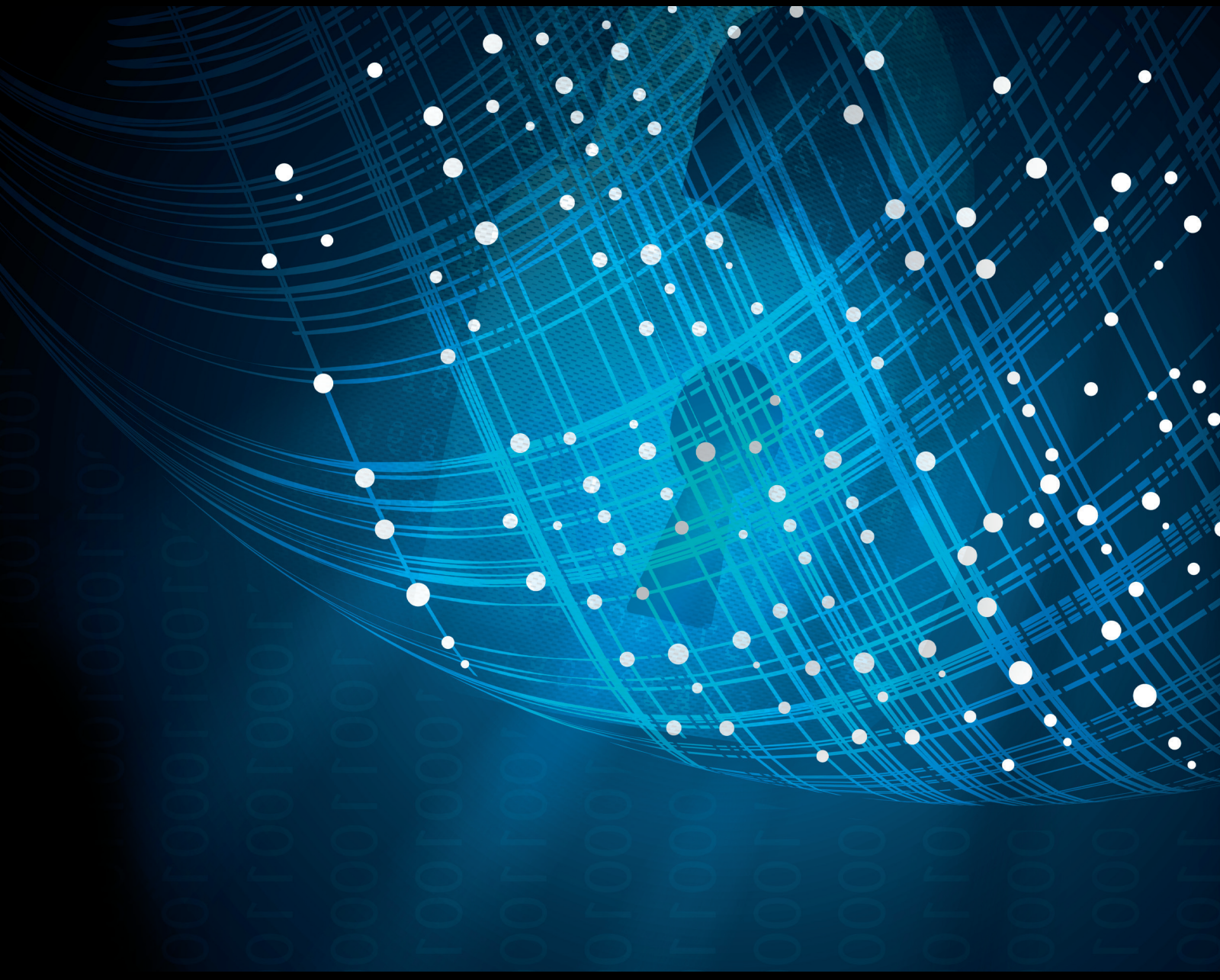
Security and Communication Networks

Intelligent Reflecting Surfaces for Safeguarding Cellular Communication Networks

Lead Guest Editor: Liang Yang
Guest Editors: Zahid Halim and Jun Liu



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Contents

Retracted: A Recommended Approach to Classical Literature and Art Exhibition Activities Oriented towards Interactive Modelling
Security and Communication Networks
Retraction (1 page), Article ID 9850126, Volume 2024 (2024)

Retracted: Research on Value Co-Creation New Business Model of Import Cross-Border E-Commerce Platform Ecosystem
Security and Communication Networks
Retraction (1 page), Article ID 9845493, Volume 2024 (2024)

Retracted: Resilience Assessment and Risk Prediction in Supply Chain Management Based on Network Analysis
Security and Communication Networks
Retraction (1 page), Article ID 9841928, Volume 2024 (2024)

Retracted: Analysis of Multimodal Teaching of College English under the Background of Artificial Intelligence
Security and Communication Networks
Retraction (1 page), Article ID 9840242, Volume 2024 (2024)

Retracted: Analysis and Application of Data Mining Technology for College English Education Integration
Security and Communication Networks
Retraction (1 page), Article ID 9836129, Volume 2024 (2024)

Retracted: Intelligent Detection and Analysis of Wearable Devices in Wushu Training
Security and Communication Networks
Retraction (1 page), Article ID 9818401, Volume 2024 (2024)

Retracted: Optimization and Combination Analysis of English Multimodule Learning Strategies based on Computational Intelligence
Security and Communication Networks
Retraction (1 page), Article ID 9804763, Volume 2024 (2024)

Retracted: Analysis of University Education Management Based on Artificial Intelligence
Security and Communication Networks
Retraction (1 page), Article ID 9792171, Volume 2024 (2024)

Retracted: Psychological Consultation and Health Analysis Method for Artificial Intelligence Multidecision Support
Security and Communication Networks
Retraction (1 page), Article ID 9792142, Volume 2024 (2024)

Retracted: Design of the Music Intelligent Management System Based on a Deep CNN
Security and Communication Networks
Retraction (1 page), Article ID 9791723, Volume 2024 (2024)

Contents

[Retracted] Teaching Archives Information Management and Quality Diagnosis Method from the Perspective of Collaborative Education Based on Intelligent Computing
Tieli Liu, Liansheng Tang, Liqiong Yao, and Geng Zhu
Research Article (12 pages), Article ID 4194667, Volume 2022 (2022)

[Retracted] Research on Value Co-Creation New Business Model of Import Cross-Border E-Commerce Platform Ecosystem
Cheng Peng, Xi Jing, Jing Tie, Yue Tian, Jiyu Kong, Ke Xue, and Yu Zhou
Research Article (14 pages), Article ID 8726075, Volume 2022 (2022)

[Retracted] Analysis of English Education Quality Evaluation and Internationalization Integration Based on Deep Learning
Yaqin Song and Gongping Yang
Research Article (9 pages), Article ID 9436538, Volume 2022 (2022)

[Retracted] Design of the Music Intelligent Management System Based on a Deep CNN
Jinghan Shang and Fei Shao
Research Article (9 pages), Article ID 1559726, Volume 2022 (2022)

[Retracted] Psychological Consultation and Health Analysis Method for Artificial Intelligence Multidecision Support
Ye Jin and Aheng Liu
Research Article (9 pages), Article ID 8957082, Volume 2022 (2022)

[Retracted] High-Quality Development of Leisure Agriculture in Jiangsu Province in the New Period: From the Perspective of Non-Technological Innovation
Xin Li and Lei Li
Review Article (9 pages), Article ID 1293821, Volume 2022 (2022)

[Retracted] Analysis and Application of the Business English Translation Query and Decision Model with Big Data Corpus
Jufang Gong
Research Article (10 pages), Article ID 2714079, Volume 2022 (2022)

[Retracted] Evaluation Method and Implementation of Vocal Music Teaching Performance under a Wireless Communication Environment
Hengbo Liu
Research Article (9 pages), Article ID 2597772, Volume 2022 (2022)

[Retracted] Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion
Lu Bai and Yingying He
Research Article (10 pages), Article ID 1971341, Volume 2022 (2022)

Contents

[Retracted] Text Mining of Movie Animation User Comments and Video Artwork Recommendation Based on Machine Learning
Haoran Gong
Research Article (9 pages), Article ID 2800481, Volume 2022 (2022)

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Jing Chen
Research Article (11 pages), Article ID 6118196, Volume 2022 (2022)

[Retracted] Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence
Shangzi Yun, Yongfeng Bai, and Baek Jongnam
Research Article (10 pages), Article ID 6322570, Volume 2022 (2022)

[Retracted] Blockchain-Based Intelligent Interconnection System Optimization Decision
Caifeng Wang, Shenghua Hao, and Yufang Ma
Research Article (12 pages), Article ID 6818562, Volume 2022 (2022)

[Retracted] Application of Deep Learning Algorithm in Web Page Advertising Design Style
Qing Deng, Ning Yang, and Na Yang
Research Article (9 pages), Article ID 6355098, Volume 2022 (2022)

[Retracted] Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System
Ben Tian, Zhaogang Xie, and Wei Peng
Research Article (9 pages), Article ID 8999757, Volume 2022 (2022)

[Retracted] Analysis of University Education Management Based on Artificial Intelligence
Hongmei Zhu
Research Article (11 pages), Article ID 8132523, Volume 2022 (2022)

[Retracted] Analysis of Painting Elements of Tea Culture and Art Works Based on Image Perception
Haiting Zhao
Research Article (9 pages), Article ID 2439464, Volume 2022 (2022)

[Retracted] Paper-Cutting Pattern Design Based on Image Restoration Technology
Jianjun Yu
Research Article (9 pages), Article ID 3132047, Volume 2022 (2022)

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Analysis and Application of Data Mining Technology for College English Education Integration

Security and Communication Networks

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Intelligent Detection and Analysis of Wearable Devices in Wushu Training

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Security and Communication Networks
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Retraction

Retracted: Optimization and Combination Analysis of English Multimodule Learning Strategies based on Computational Intelligence

Security and Communication Networks

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Analysis of University Education Management Based on Artificial Intelligence

Security and Communication Networks

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Hindawi
Security and Communication Networks
Volume 2024, Article ID 9792142, 1 page
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Retraction

Retracted: Psychological Consultation and Health Analysis Method for Artificial Intelligence Multidecision Support

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Hindawi
Security and Communication Networks
Volume 2024, Article ID 9791723, 1 page
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Retraction

Retracted: Design of the Music Intelligent Management System Based on a Deep CNN

Security and Communication Networks

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Hindawi
Security and Communication Networks
Volume 2024, Article ID 9787325, 1 page
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Retraction

Retracted: Analysis and Application of the Business English Translation Query and Decision Model with Big Data Corpus

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Evaluation Method and Implementation of Vocal Music Teaching Performance under a Wireless Communication Environment

Security and Communication Networks

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Analysis of English Education Quality Evaluation and Internationalization Integration Based on Deep Learning

Security and Communication Networks

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Hindawi
Security and Communication Networks
Volume 2024, Article ID 9764159, 1 page
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Retraction

Retracted: Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence

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[1] S. Yun, Y. Bai, and B. Jongnam, "Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 6322570, 10 pages, 2022.

Hindawi
Security and Communication Networks
Volume 2023, Article ID 9802741, 1 page
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Retraction

Retracted: Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System

Security and Communication Networks

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[1] B. Tian, Z. Xie, and W. Peng, "Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System," *Security and Communication Networks*, vol. 2022, Article ID 8999757, 9 pages, 2022.

Hindawi
Security and Communication Networks
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Retraction

Retracted: Enterprise Financial Risk Prediction and Prevention Based on Big Data Analysis

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Hindawi
Security and Communication Networks
Volume 2023, Article ID 9807292, 1 page
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Retraction

Retracted: High-Quality Development of Leisure Agriculture in Jiangsu Province in the New Period: From the Perspective of Non-Technological Innovation

Security and Communication Networks

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Hindawi
Security and Communication Networks
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Retraction

Retracted: Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion

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[1] L. Bai and Y. He, "Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion," *Security and Communication Networks*, vol. 2022, Article ID 1971341, 10 pages, 2022.

Hindawi
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Retraction

Retracted: Resilience Assessment and Risk Prediction in Supply Chain Management Based on Network Analysis

Security and Communication Networks

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[1] L. Zhu, "Resilience Assessment and Risk Prediction in Supply Chain Management Based on Network Analysis," *Security and Communication Networks*, vol. 2022, Article ID 7873338, 9 pages, 2022.

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Research Article

Resilience Assessment and Risk Prediction in Supply Chain Management Based on Network Analysis

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As an important link of enterprise development, supply chain management should cause enterprise managers to attach great importance in order to enhance the competitiveness of enterprises. Based on enterprise supply chain management, this paper analyzes the current situation and risks of enterprise supply chain management and predicts the risks of supply chain management through network analysis. Supply chain management has strong resilience and can cope with greater risks for itself and various risk situations in the industry. The influence weight of risk types is assessed. The top three factors will restrict the supply chain management of enterprises and are factors that cannot be tolerated by management. In management practice, the influence should be avoided or mitigated as far as possible to improve the management level. In addition, corresponding measures are put forward according to the characteristics of enterprises, and scientific suggestions are provided for the development of enterprises. This assessment can be used as the basis of enterprise supply chain management risk control management decisions.

1. Introduction

The twenty-first century is an era of high modernization, knowledge, and informationization. People enjoy the convenience of contemporary society all the time. The vigorous development of the logistics industry and e-commerce enables people to quickly obtain what they need. It can even be asserted that the speed of circulation of commodities today is much higher than at any moment in the history of human society. Every second that people pass by, hundreds of commercial orders are placed on the Internet, and consumers just need to easily pick up and confirm on the Internet to complete the commercial order. Such a convenient and fast way of shopping is inseparable from the dependence on Internet technology. In order to adapt to the era of rapid development, logistics management and supply chain management and other industries are gradually informatized, automated, and unmanned. In the new era of Internet development, the organic combination of the Internet and the enterprise supply chain has become an inevitable development of the times, and the internet of things has emerged as the times require. As the product of the "Internet +" supply chain, IoT not only optimizes supply chain management but also enhances enterprise management efficiency. The development of the Internet has thus transformed the traditional state of separation between product suppliers and customers in the supply chain into a joint state, and product suppliers have changed from speculating about customer needs to use the Internet to mine customer demand information and meet customer needs in a timely manner. For example, in the logistics and transportation process, the application of the IoT (internet of things) technology can timely feed back the location information of the cargo transportation to each node enterprise through the supply chain, which is convenient for the enterprise to grasp the cargo location information at the first time and scientifically allocate the logistics vehicles, so as to enhance the efficiency of vehicle transportation and significantly improve the supply chain management efficiency. At the same time, in the manufacturing process, the application of internet of things technology helps staff control and track product production quality in a timely manner, improve the transparency of the entire production and operation process, and enhance the production efficiency of

enterprises. In addition, in the operation and development of enterprises, information sharing is very important for communication between various departments. Although the enterprise used the supply chain management mode before, there are still many deficiencies in technical support and information exchange, and the information lag affects the integration of enterprise resources. With the development of science and technology, the supply chain management mode has been optimized, which provides a bridge for communication and exchanges between various departments of the enterprise, realizes the sharing of information resources among enterprises, and improves the utilization rate of enterprise information. In addition, the new supply chain management model provides convenience for enterprises to cooperate with external enterprises, thereby attracting more potential customers, obtaining relevant information, and promoting the sustainable development of enterprises.

This topic has become popular [1, 2]. It has become an important part of business management. It mainly refers to enterprise managers using the business process between suppliers and customers to identify, analyze, and evaluate the development of internal economic activities and the operation of monetary funds in the enterprise. Guarantee the normal operation of business activities through appropriate risk management procedures [3, 4]. Through the replanning of the distribution of suppliers, the program is more concise, and the data information is more real, and the resources between all suppliers are unified and coordinated to form a complete coordination chain of data and objects [5, 6].

With the continuous application of supply chain management, it has become a good competitive target and means for enterprises [7]. Domestic construction enterprises, especially large construction enterprise groups, have increasingly serious homogeneous competition, and the barriers to technology and market access have been continuously reduced. Management innovation and continuous improvement of supply chain management level have become an inevitable choice for enterprises to maintain their competitive advantage and remain invincible [8]. With the increasingly complex changes in the international economic situation, the in-depth adjustment of the domestic economic structure, and the increasing competition among enterprises, the competition of supply chain management has become an important part of the competition in the construction industry, and the advantages of the supply chain have become the core value of leading companies [9–11]. Supply chain management evaluation will be the only way for enterprise development and the necessity of sustainable development.

At present, the research on inventory control performance of supply chains mainly adopts the analytic hierarchy process (AHP) and fuzzy AHP [12]. The analytic hierarchy process mainly divides the system into multiple layers; each time, only the relationship between the upper layer and the lower layer needs to be considered; and there will not be too many connections between each layer. This precondition simplifies the relationship between the elements in the system, and in the supply chain inventory, the elements of each layer and the elements in the same layer affect each other. Using the AHP method to study inventory control performance reflects the real level of inventory control comprehensively and scientifically [13–15]. Therefore, this paper uses the analytical network process (ANP) to evaluate and predict the risk of supply chain management.

2. Resilience and Risk of Supply Chain Management

What is resilience? This concept was first proposed in 2003 and was defined in 2004 as "the ability of a supply chain to return to its original or more desirable state after disruption." In layman's terms, the resilience of the supply chain means that when an enterprise is faced with a huge impact, its supply chain can still move, produce, and deliver, helping the company to survive the crisis. Throughout the past two decades, in the context of globalization, the supply chain has become more and more complex, and factors affecting the resilience of the supply chain have emerged in an endless stream. Natural disasters, trade conflicts, political conflicts, regional situations, epidemics, and global economic crises have all brought huge hidden dangers to the supply chain, and they are affecting the stability of the supply chain all the time. In the face of emergencies in the general environment, if the supply chain is stuck in the throat, even large and powerful enterprises may suffer huge economic losses or even close to bankruptcy or face serious consequences such as bankruptcy. Therefore, companies must have a strategy to deal with supply chain uncertainty before risks arrive. Building and maintaining a resilient supply chain will become a powerful tool for enterprises to bravely advance in the face of risks, and the continuously enhanced supply chain risk response capability will also help enterprises ride the wind and waves and set sail in an era full of changes.

Supply chain management has great advantages. First of all, the realization of supply chain management can bring huge economic benefits to the enterprise. For enterprises, the application of supply chain management can speed up the reaction speed of the market and make the internal logistics channels, functions, and transportation of the enterprise more efficient. To improve the links and other aspects, it is necessary to expand the scope of logistics services and help enterprises better adapt to the reform of the modern economic system. Especially in the "Internet +" era, through the effective application of information technology, the process of supply chain management is more transparent, which greatly reduces problems such as the backlog of goods, delayed delivery, and transportation, and brings more considerable economic benefits to enterprises [16]. Of course, businesses can gain additional profits through this management. Second, it can greatly improve the efficiency of enterprises. Enterprises can separate each other's data through the supply chain and thus avoid data loss; through supply chain management, enterprises can achieve unification and scale, thereby reducing costs caused by management; Third, in supply chain management, various enterprises can establish strategic cooperation alliances, and the transaction costs between them will be greatly reduced.

Fourth, with the development of science and technology, this management model not only connects enterprises in the industry but also brings the advantages of resource sharing to various enterprises. Enterprises should make good use of big data technology and constantly explore the development of a smart supply chain. Enterprises can also use the technology of human-computer interaction. Through the use of virtual reality, they can integrate their own advantages and auxiliary systems, which can improve the quality of production and logistics, and contribute to sustainable development. This management mode allows each other's enterprises to share resources and information and continuously improve their own management level. Supply chain management mainly consists of the following risks [17]:

(1) Compared with the supply chain management optimization work of foreign enterprises, the level of informatization of employees in Chinese enterprises is generally relatively low. At the same time, many hardware devices of information technology have not kept up in time, thus hindering the informatization development of enterprises. In addition, under the circumstance that online transactions are becoming more and more transparent, the work and management concepts of enterprise employees are too traditional and lack the ability to use computers, and some enterprise employees are more resistant to online transactions and ignore the regulations and instructions of the enterprise, which will increase the degree of difficulty in operation. This in turn hinders the improvement of the level of supply chain management.

(2) With the establishment of the enterprise's online sales system, the product transaction volume of the enterprise has also increased significantly, and there are also new requirements for distribution work. Although the enterprise will increase the warehouse on the way of delivery in order to ensure the efficiency of the transportation work, it does not pay attention to the management work, resulting in various problems in the management process, and neither customers nor the enterprise can obtain timely logistics information, thus affecting the level of enterprise supply chain management.

(3) In the "Internet +" environment, many large enterprises have established their own e-commerce websites, and the products they sell are limited to their own platforms. But what needs to be known is that many suppliers and users are on their own platforms, and some small businesses cannot attract more customers and suppliers. Small and medium-sized enterprises can conduct transactions through their respective platforms and strengthen business alliances in order to improve the level of supply chain management [18].

(4) With the continuous reform and development of the market, the competition among enterprises has become more and more fierce. With the emergence of the Internet economy, enterprises have gradually changed from a traditional single competition method to a diversified one. At this time, supply chain management is becoming more and more important, and management quality directly affects the development of enterprises. However, most enterprises in our country are influenced by traditional concepts, and their awareness of supply chain management is weak. In the process of enterprise management, although supply chain management ideas are also reflected and the basic methods of supply chain management are adopted, the supply chain management awareness has not penetrated into the hearts of management; it is difficult to reach a consensus inside and outside the enterprise so that the supply chain cannot become a value chain. The main purpose of the existence of the supply chain is to use each node on the supply chain to maximize the coordinated development of the resources of each node and provide high-quality services to customers. In fact, most enterprises in our country still follow the traditional mode of operation. Although they constitute a supply chain, the enterprises at each node still focus on their own interests and manage their own affairs, ignoring the direct communication and coordination of each node. It leads to a waste of resources, and most collaborative work is directly affected, which directly hinders the collaborative development of enterprises.

All in all, in supply chain management, various management systems not only have application resilience but also have various management risks, which require mutual support between enterprises to reduce risks.

3. Model Introduction

3.1. Basic Steps of the ANP Method

(1) Establish a system structure model. For a decision-making problem, it is first necessary to carry out a systematic analysis, study the interdependence and feedback relationship between judgment elements and levels, define decision-making goals and criteria, and then construct an ANP model formed by the control layer and the network layer.

(2) Determine the weight of each evaluation index in the evaluation system and construct a supermatrix. Since the network analysis method considers the information feedback between different levels and the interdependence between the elements of the same layer, it is more complicated than the AHP when determining the weight. It is no longer a simple comparison of two elements to the upper elements, but the degree to which each element is affected by other elements needs to be determined. The network matrix composed of the weight values of each element is a supermatrix.

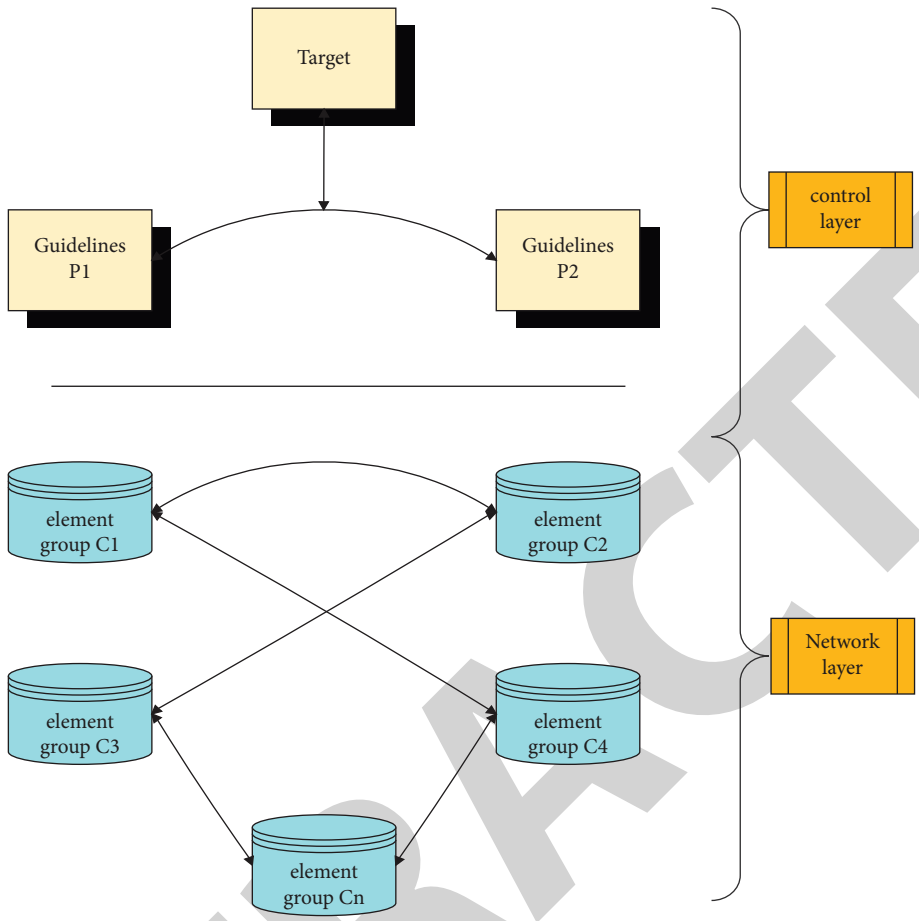

Figure 1: Classical ANP structure diagram.

(3) Introduce fuzzy matrix. Each factor is scored by experts, and a fuzzy evaluation matrix representing the membership degree of each element to the evaluation result grade is established by the fuzzy comprehensive evaluation method.

(4) Calculate the results and analyze the overall level.

(5) Analyze and predict supply chain risk management, analyze and compare the predicted results, and formulate corresponding risk avoidance measures to provide a good scientific basis for enterprise supply chain risk management.

3.2. Model Frame. ANP is the detection, analysis, and diagnosis of all transmitted data in the network, helping users to eliminate network accidents, avoid security risks, improve network performance, and increase the value of network availability. ANP includes a control layer and a network layer, and the elements are independent of each other (Figure 1) [19–21].

Assuming that there are N element groups in the network layer, first, based on ei k (i = 1⋯*N;* k = 1⋯n) in the element group Ci, construct the element (j = 1⋯n; l = 1⋯m) in the element group Cj ⋯m), then compare the relative importance of eik, that is, the judgment matrix, and obtain the sorting vector (ω(ik) j1, ω(ik) j2, ⋯, ω(jlik), ⋯, ω(ik) jm by the characteristic root method) T, and $\sum\omega$(jlik) = 1. Other elements are obtained by analogy; then $Wij = 0$.

$$A = \begin{bmatrix} W_{j1}^{i1} & W_{j1}^{i2} & \dots & W_{j1}^{ik} & \dots & W_{j1}^{in} \\ W_{j2}^{i1} & W_{j2}^{i2} & \dots & W_{j2}^{ik} & \dots & W_{j2}^{in} \\ \dots & \dots & \dots & \dots & \dots & \dots \\ W_{jm}^{i1} & W_{jm}^{i2} & \dots & W_{jm}^{ik} & \dots & W_{jm}^{in} \end{bmatrix}. \quad (1)$$

There are $N \times N$ such sorted matrices in total. The supermatrix W is obtained by forming sub-blocks from the sorted matrix. Then start solving the supermatrix as follows:

$$W = \begin{bmatrix} W_{11} & W_{12} & \dots & W_{1N} \\ W_{21} & W_{22} & \dots & W_{2N} \\ \dots & \dots & \dots & \dots \\ W_{N1} & W_{N2} & \dots & W_{NN} \end{bmatrix}. \quad (2)$$

The judgment matrix is obtained by weighting the supermatrix, and the normalized eigenvector is obtained by the eigenroot method.

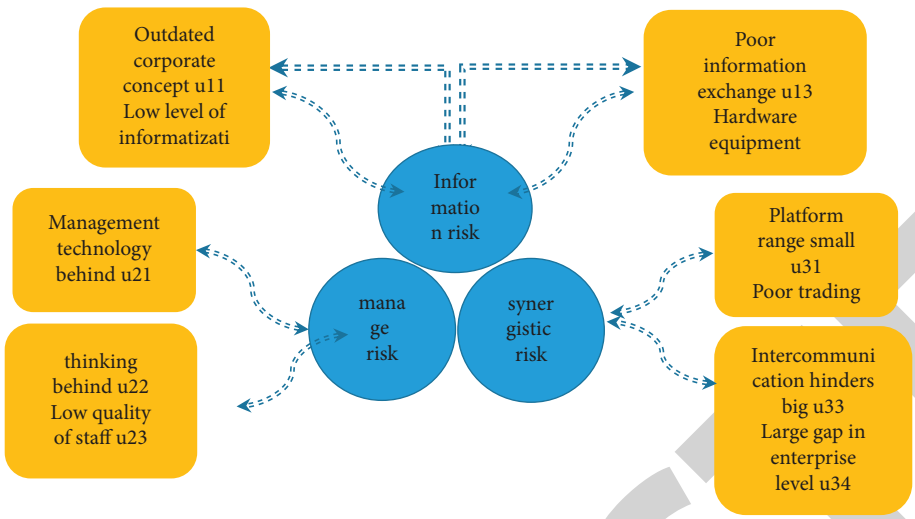

Figure 2: Risk investigation map.

$$A' = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1N} \\ a_{21} & a_{22} & \dots & a_{2N} \\ \dots & \dots & \dots & \dots \\ a_{N1} & a_{N2} & \dots & a_{NN} \end{bmatrix}. \quad (3)$$

$W^{-} = A \times W$ is the weighted supermatrix W^{-}. Finally, as $W\infty = \lim t \longrightarrow \infty W^{-}\ t$ exists, that is to get the limit supermatrix $W\infty$.

4. Model Building Application

4.1. Raw Data Collection. Through the inspection of actual enterprises, the production of forms to solicit opinions, and the convening of expert meetings to obtain risk indicator data, these data have been discussed and analyzed by the investigation and research group and evaluated by the expert group, and the data has certain reliability. Obtain a risk survey map based on a large amount of enterprise management data (Figure 2). Supply chain management risk mainly includes three first-level indicators: informatization risk U1, management risk U2, and collaboration risk U3, as well as outdated corporate concepts u11, low level of informatization u12, poor information exchange u13, backward hardware and equipment u14, backward management technology u21, backward thinking u22, low quality of employees u23, small platform scope u31, poor transaction ability u32, and great barriers to interoperability u33. There is a big gap with the enterprise level u34 11 secondary indicators. Among them, the informatization risk U1 mainly depends on the development level of the company and the information level of the current era and belongs to social factors. The management risk U2 mainly refers to the internal management of the enterprise, and its own management is the main factor. It is the improvement of the enterprise through its own restraint. Collaborative risk U3 is mainly industry risk. The development of the industry directly restricts the development of enterprises and is also the main indicator of supply chain management risk. These indicators can reflect the risk factors of supply chain management in enterprise operations. Therefore, the overall target risk factor set of the model is expressed as follows:

$$U = [U_1, U_2, U_3]. \quad (4)$$

The model's secondary target risk factor set is expressed as follows:

$$\begin{aligned} U_1 &= [u_{11}, u_{12}, u_{13,} u_{14}], \\ U_1 &= [u_{11}, u_{12}, u_{13,} u_{14}], \\ U_3 &= [u_{31}, u_{32}, u_{33,} u_{34}]. \end{aligned} \quad (5)$$

Through the statistical analysis of the probability of occurrence and the degree of influence of each risk indicator in Figures 2, the relationship between the probability of risk occurrence and the degree of harm is obtained Figures 3. According to the analysis, the degree of impact and the possibility of risk occurrence are divided into five levels, among which the degree of impact is divided into "intolerable," "significant impact," "significant impact," "tolerable," and "negligible." The probability of risk occurrence is divided into "very likely," "probable," "probable," "unlikely," and "negligible." As can be seen from Figure 3, the most serious impact is "intolerable," which has the highest probability of occurrence; use "significant impact," "significant impact," "tolerable," and "negligible"to indicate the likelihood of occurrence. The sexuality gradually decreases, indicating that some factors that may occur can be ignored. It can be considered as a secondary factor in the actual management of the company's supply chain, mainly considering the risk of "cannot be easy." Each data in the figure clearly shows the relationship between risk factors and the possibility of risk occurrence.

4.2. Calculate the Weight of the First-Level Indicator and the Weight of the Second-Level Indicator. Building an ANP network is shown in Figure 4. According to the formula of

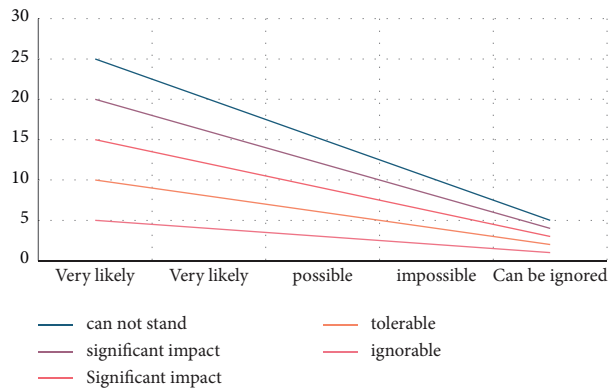

Figure 3: The relationship between the probability of occurrence of the risk and the degree of harm.

the network analysis method, the weight vectors of the first-level indicators under the conditions of each sub-criteria are calculated. The combination of the weight vectors can obtain the judgment matrix A for the first-level indicators, and the weight ratio of the first- and second-level indicators can be obtained through statistical analysis. Indicator weight ratio is provided in Figures 56. As can be seen from Figure 4, the first-level index synergy risk weight in supply chain management risk is 0.42, accounting for the largest proportion, which is the main factor of supply chain management risk, followed by management risk, accounting for 0.32, and information risk accounting for the smallest, accounting for 0.24. It can be seen from Figure 5 that the weights of secondary indicators vary greatly. The main proportion is the sub-factor in collaborative management, and the smallest is the sub-factor of information management, which is exactly in line with Figure 4. The level gap accounts for the largest proportion and is also the main factor for the secondary indicators. The second is the backward management technology of the secondary indicators, which mainly belong to the internal management of enterprises and can be improved by reforming the management system. The proportion of other secondary indicators is relatively small, which is the main factor of supply chain management risk. These main factors can be dealt with by simple measures or ignored in management. Key risks with high impact need to be analyzed.

$$A = \begin{bmatrix} 0.1134 & 0.1243 & 0.1512 \\ 0.3425 & 0.6127 & 0.3427 \\ 0.2611 & 0.3228 & 0.6112 \end{bmatrix}. \quad (6)$$

4.3. Calculate and Construct Judgment Matrix W. Taking W12 as an example, construct and calculate the judgment matrix. Taking u21 as the secondary criterion, the risk judgment of each element in the information risk set U1 can be obtained, and the dominance degree and normalized eigenvector of each element in the element set U1 can be obtained, as shown in Figure 7.

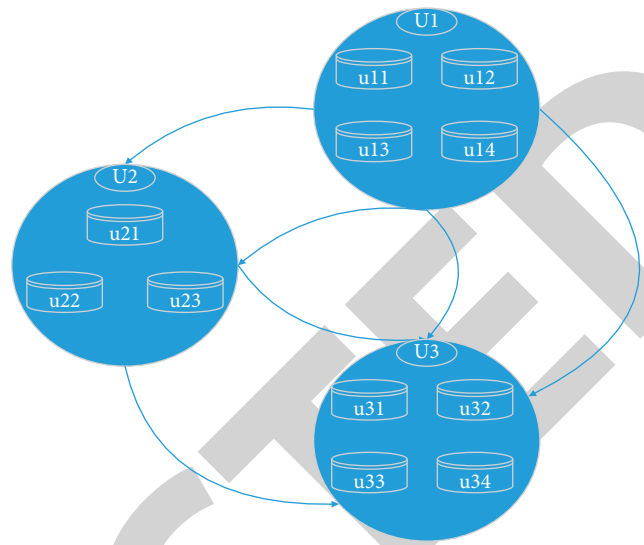

Figure 4: ANP network layer composition.

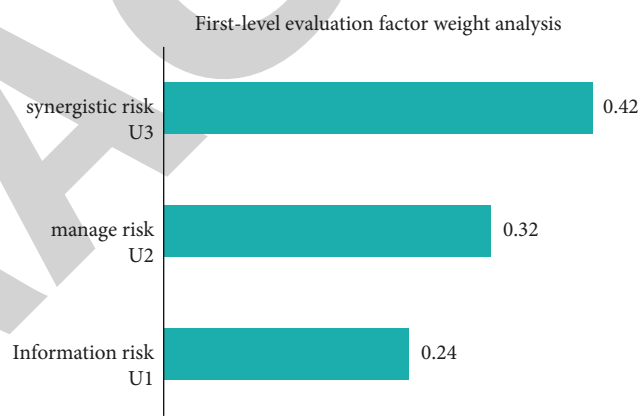

Figure 5: First-level indicator weight analysis.

Then, using u22 and u23 as the sub-criteria, the risk judgment of each element in U1 can also be obtained, and the dominance degree and normalized eigenvector of each element in the element set can also be obtained. And the normalized eigenvector composition scheme that can be obtained from the selection risk set U1 relative to the judgment matrix W12 of each element in the risk set U2 is

$$W_{12} = \begin{bmatrix} 0.0711 & 0.0572 & 0.0598 \\ 0.5281 & 0.3415 & 0.4003 \\ 0.3141 & 0.5211 & 0.4195 \\ 0.0730 & 0.0795 & 0.0949 \end{bmatrix}. \quad (7)$$

4.4. Construct Weighted Supermatrix and Normalize Limit Ordering Vector. According to the first-level index weight matrix A and the supermatrix W, the weighted supermatrix E is constructed. According to $\lim_{n \longrightarrow \infty} E_n$, the normalized limit

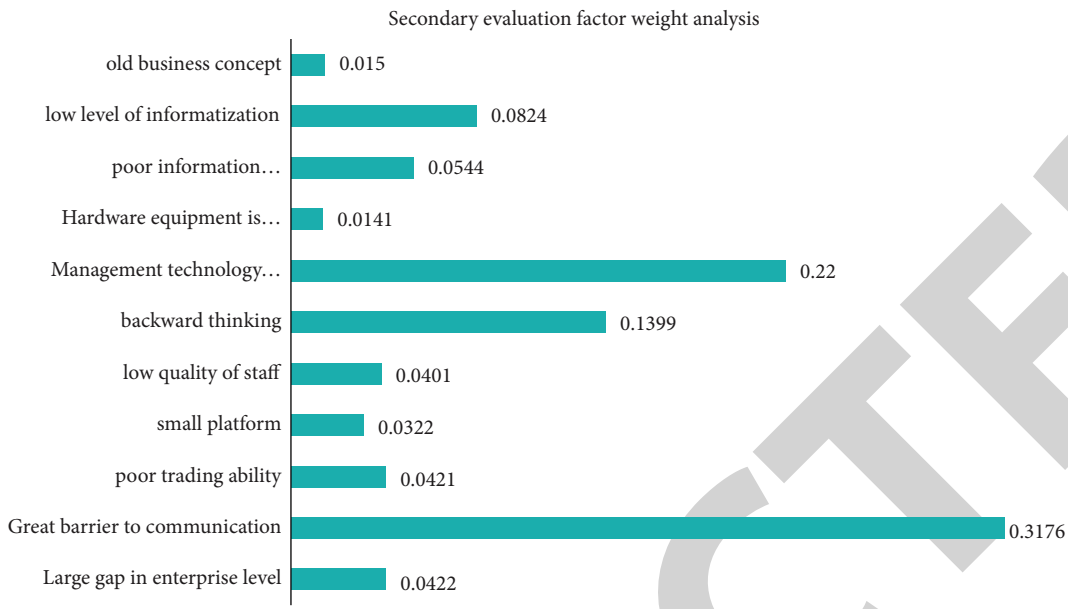

Figure 6: Secondary indicator weight analysis.

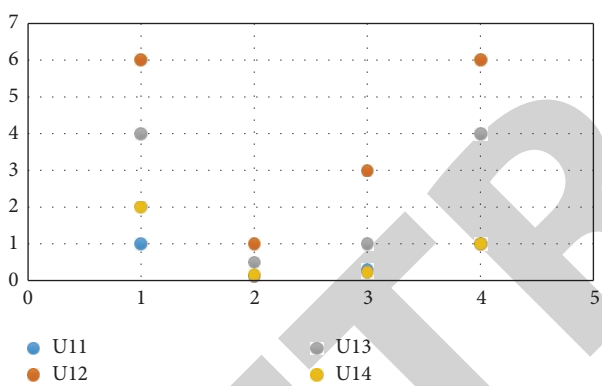

Figure 7: Comparison of the dominance of elements in U1.

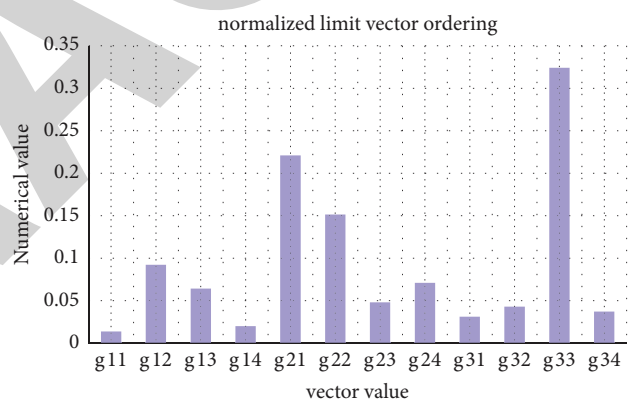

Figure 8: Normalized limit vector ordering.

sorting vector G of the weighted supermatrix E is obtained, and Figure 8 is obtained through statistical analysis.

$$\begin{aligned} W &= \begin{bmatrix} W_{11} & W_{12} & W_{13} \\ W21 & W_{22} & W_{23} \\ W_{31} & W_{32} & W_{33} \end{bmatrix}, \\ E &= \left(a_{ij} W_{IJ}\right) \\ &= \begin{bmatrix} a_{11}W_{11} & a_{12}W_{12} & a_{13}W_{13} \\ a_{21}W_{21} & a_{22}W_{22} & a_{23}W_{23} \\ a_{31}W_{31} & a_{32}W_{32} & a_{33}W_{33} \end{bmatrix}, \\ G &= \lim_{n \longrightarrow \infty} E_n. \end{aligned} \tag{8}$$

5. Analytical Discussion

According to the ordering of the normalized limit vector, it is known that its maximum value is 0.3240 corresponding to g34 (Figure 6). According to Figure 2, the ranking risk factor represented by it is the large gap in the enterprise level u34, which is very important. The second value is 0.221; 0 corresponds to g21, which represents the ranking risk factor of backward management technology u21; the risk of the third thought behind u22 corresponds to a value of 0.1514. All other values are less than 0.1, indicating that other factors have little influence or can be ignored. The final weights are ranked as follows: outdated enterprise concept u11, backward hardware equipment u14, poor transaction ability u32, great intercommunication barrier u33, low quality of staff u23, small platform scope u31, and so on. The order of sorting can give enterprises a clear direction of supply chain risk management, and enterprises can solve risk management priorities according to the size of supply chain management risks. It can be seen that management is not only resilient enough but also has many risk factors. Among them, the collaborative risk of supply chain management is the main risk factor, which should be the focus of future management.

Therefore, enterprises should prepare corresponding supply chain management strategic measures. First of all, enterprises need to formulate specific management goals, carry out business activities according to specific management goals, and formulate good and effective goals according to the actual situation of the enterprise. When setting specific enterprise supply chain management goals, it is necessary to make accurate judgments on the basis of the actual development of the enterprise. Development goals strengthen the level of logistics control management from the theoretical level. Second, enterprises should establish a unified supply chain management information system and formulate a standardized and unified management system, code of goods and services, and management procedures. Using many scientific and technological means to realize the real-time flow and sharing of various enterprise information, bring immeasurable information exchange space to each enterprise, bring advanced results to its management, and form a data closed loop in the whole process of the supply chain. Finally, supplier risk management can help companies monitor supplier risks at any time during the process of introducing suppliers and cooperating with suppliers and respond to the changing global market environment. Central construction enterprises should carry out supply chain risk management, as an important part of the comprehensive risk management system, and establish a risk management and control system that runs through the entire business process of the supply chain such as demand, procurement, and supply. In addition, improve the electronic risk identification function of the supply chain system and develop the risk monitoring function of automatic supervision, automatic identification, and automatic early warning. Units at all levels should formulate risk prevention and control plans for supply chain risk prevention and control points. When risks occur, they can select and implement corresponding emergency plans according to the actual situation to reduce losses caused by risks. In the entire system of the supply chain, each enterprise that constitutes the supply chain can be regarded as an organizational department, and the supply chain management of each organizational department is carried out. In the process of continuous adjustment and change of the market, the market demand will also change, so the enterprises in the supply chain are not fixed and will adjust with market demand accordingly. Efficient supply chain management can fundamentally achieve the strategic development goals of the enterprise, reduce the probability of enterprise risks, shorten the capital turnover cycle, and realize the economic development of the enterprise's rapid growth in benefits. Therefore, continuously strengthening the research on enterprise supply chain management and supply chain strategy mode plays an important role in promoting the rapid development of enterprises [22]. All in all, in today's advanced technology, many communication platforms have been established between enterprises through the supply chain. Each industry has played its own advantages, developed together, avoided controllable risks, and ultimately benefited all enterprises in the industry.

6. Conclusion

With the development of all walks of life, the competition between enterprises is becoming fiercer. If each other cannot be united and isolated from each other, each enterprise cannot last for a long time. In the face of such a market environment, every enterprise needs to consider how to build each other together. To this end, the supply chain model will provide a new development direction for the development of the enterprise. Enterprises can take the supply chain as an opportunity to manage the operation of the enterprise in a scientific and modern way, provide customers in the industry with stable services and reliable reliability, and meet the needs of customers with high quality. In addition, each enterprise should consider long-term planning and management, which not only provides a certain guarantee for its own foothold and development in the industry but also provides the efficiency of enterprise operation, thereby improving the efficiency of the enterprise and laying a scientific and effective basis for the comprehensive development of the enterprise.

In this paper, the network analysis method is used to evaluate the resilience and predict the risk in enterprise supply chain management; the risk evaluation model is constructed; and the ranking weight of the risk at each level is obtained, which provides the basis for the decision makers to make fast, efficient, and reliable decisions.

(1) Using the network analysis method, a risk assessment model is constructed by superimposing risk factors at multiple levels. A sample form of risk investigation was determined based on secondary risk factors, and the investigation scope involved industry experts, managers, on-site technical management, and payroll personnel. The risk factor weight level of the quantitative index is obtained through the risk evaluation model. The ranking reflects the weight of each factor affecting the supply chain management, which is in line with the current practical experience of enterprise supply chain management and can be used as the basis for risk control management decision-making or as a calculation.

(2) Enterprise supply chain management has strong resilience, can cope with common risks and some more complex risks in the industry and management, and provide a certain guarantee for the enterprise's own management. The supply chain management level of an enterprise is affected by multilevel factors, so it is also accompanied by a variety of risks, including informatization risks, management risks, collaboration risks, and so on. Therefore, choosing the most suitable sustainable supplier for the company itself requires consideration. One of the factors to consider is screening based on the challenges the business faces. Businesses need to communicate their company vision and values to suppliers in order to set the right expectations. The common way for enterprises in

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Retraction

Retracted: Teaching Archives Information Management and Quality Diagnosis Method from the Perspective of Collaborative Education Based on Intelligent Computing

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] T. Liu, L. Tang, L. Yao, and G. Zhu, "Teaching Archives Information Management and Quality Diagnosis Method from the Perspective of Collaborative Education Based on Intelligent Computing," *Security and Communication Networks*, vol. 2022, Article ID 4194667, 12 pages, 2022.

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Research Article

Teaching Archives Information Management and Quality Diagnosis Method from the Perspective of Collaborative Education Based on Intelligent Computing

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With the growth of better education, improving the quality of better education has become a top priority. In order to facilitate the sustainable and healthy growth of better education and continuously improve the quality of education for faculty and staff, the Ministry of Education has established a regular assessment system for undergraduate-level education. This article analyzes the quality diagnosis of teaching archives management from the perspective of collaborative education by using the bionic method and summarizes the three methods. In the precision rate, the user interface is the highest, followed by accuracy, security requirements, hardware environment, system maintenance, and information flow; in the recall rate, the security requirements are the highest, followed by the hardware environment, accuracy, user interface, information flow, and system maintenance; in F1, the user interface is the highest, followed by hardware environment, information flow, accuracy, security requirements, and system maintenance. In the particle swarm optimization coverage algorithm, the security requirements are obtained, the user interface accuracy is relatively high, and the hardware environment is relatively low; the system maintenance and hardware environment are the most covered, and the security requirements are the least; the number of rejected samples is the largest. It is the hardware environment and system maintenance, and the least is the security requirement; the most correct number of rejected samples is the hardware environment and system maintenance. The scientific analysis of the quality diagnosis of teaching archives management from the view of collaborative education is extremely important for improvement of teaching. The archives management system can be effective in the process of the archives hardware environment, security requirements, system maintenance, user interface, information flow, and accuracy. The efficiency of the manual management process is improved, and the process is simplified.

1. Introduction

College archives management is a hot spot for new employment in colleges and universities. How to do a great job in file management in colleges is both solid and rich. Years of experience teaching file management at universities have shown that it is associated with an active discussion [1]. The main task of teaching diagnosis and improving management quality is to formulate principles and regulations for education management, focus on management team building, monitor, diagnose, and improve the education management process, and formulate and analyze an appropriate evaluation index system. By evaluating the results, setting goals and resources for the next round of diagnosis and improvement can effectively enhance the quality of education administration [2]. Building a quality culture in higher vocational education is the basic way to enhance the internal quality assurance system and the soft means to implement the operation mechanism of education quality diagnosis. Innovate higher education quality management and reform, strengthen spiritual and cultural construction, and establish a "people-oriented" educational quality management

concept. Create an institutional culture, build a long-term mechanism for diagnostic teaching and quality reform activate behavioral culture, implement the responsibilities and missions of disciplines in the field of quality generation strengthen the material and cultural structure, and establish a material foundation for ensuring the quality of education. Promote the diagnosis and improvement system of higher occupation education through the construction of quality culture, and always enhance the quality of education [3]. As an important part of college curriculum management, curriculum information management plays an important role in improving the level of college curriculum management. This paper sorts out the connotation and characteristics of higher vocational archives, analyzes the problems existing in the archives management of higher vocational colleges, and finally clarifies the rectification measures in the field of information of higher vocational archives management [4]. With the development of the evaluation of educationally talented persons and universities, the integrity of educational archives has played a decisive part in educational evaluation, and educational evaluation has also proposed new demands for educational archives management. Therefore, browsing educational archives is imperative. Management addresses existing problems from the perspective of educational assessment and improves management accordingly [5]. Using the idea of chemotaxis, a biomimetic approach was used to describe pedestrian interactions. This is a fairly simple situation, evacuation of a large room with a door or two. The results show that changes in model parameters can describe different types of behavior, from routine to panic. We find a nonmonotonic dependence of evacuation time on the feedback constant. These times depend on the strength of the feedback behavior, with the shortest evacuation times for some intermediate values of the feedback, the correct coupling of the feedback, and the shortest path exit using knowledge [6]. The definition and history of biomimicry, the importance of biomimicry in human development, and the boundaries and progress of biomimicry are expounded. Human creativity is the fundamental engine of technological innovation. Nature and society are the disciplines we know and serve, and the best teachers are those we learn from. The development of human beings only takes 5 million years, while the evolution of life has a history of more than 3.5 billion years. While imitating human creation is important, it has a greater potential and ability to imitate nature and is more likely to increase primary innovation capabilities [7]. Under the collaborative teaching mode of industry, university, and research, the problems faced by engineering graduate students are as follows: an insufficient number of business tutors; a research initiative that needs further improvement; a lack of flexibility in graduate study; business tutor documents; course graduates; research capabilities; and a quality assurance system. Some solutions to the problem have been proposed [8]. The document acknowledges the trend toward diversification among institutions in the sector and the need for a qualitative approach tailored to specific market niches. The impact of the emergence of communication and information technology and collaborative education and social learning on the nature and quality of university education is discussed. Distrust of the quality agenda is expected to decrease as data and methodologies improve, as well as researchers' sense of control over the formative use of quality-related activities [9]. The quality of education is the driving force for the survival and growth of higher education, and classroom education is the core of university work. Classroom teaching diagnosis is a significant measure to enhance the quality of teaching, and it is also an important measure to ensure the quality and effectiveness of classroom teaching. Classroom diagnostic testing has become an urgent and significant topic in the field of current teaching and education. In recent years, the claim of "class ethnography" in the diagnosis of school education has become a useful attempt. The research results show that the diagnostic paradigm of "class ethnography" is of great significance for transforming the existing educational concepts, methods, and programs and improving the quality of education and the level of personnel training. Therefore, the diagnosis of "classroom ethnography" is worthy of promotion in practical education evaluation [10]. The article compares eight factors of the Urumqi Vocational University, including admissions, school management, placement conditions, funding, teacher team composition, apprenticeship, social assessment and external evaluation. On the basis of an analysis, the role of status data in quality diagnosis and management improvement is discussed, and it is suggested to set up a data management department in universities, establish a data management economy, and establish a data analysis mechanism at the school level to ensure the authenticity of the department level [11]. A crisis management early warning mechanism is an effective means to prevent and manage crises. Apply the quality assessment, diagnosis, and early warning mechanism of higher vocational education and take effective measures as soon as possible to improve the status of education quality, enterprise management, and teaching quality. The quality evaluation, diagnosis, and early warning system of vocational education has been continuously improved in practice and has gradually produced results [12]. The imbalance between the internal governance model and the internal quality assurance system of higher vocational education has become an obstacle to improving the quality of higher vocational education. As a part of the internal quality assurance system of colleges and universities, we investigate the use of modern management ideas and tools to build a "management" quality assurance system and coordinate the development of the internal quality assurance of each component [13]. Bionics is the study of how organisms function and the creation of mechanical or electronic devices to replicate or mimic these functions. For the first time in the history of technology, we are able to look at molecules and molecular parts and make them the size of an instrumental molecular machine. At the same time, computer technology offers surprising new possibilities. Microtechnology and microelectronics, and more recently nanotechnology, have made electromagnetic measurements possible. Using all these new technologies, engineers can build machines that

not only detect molecular changes or move organisms at the molecular level but also respond to interactions, changes, and show physical phenomena [14]. To address the inherent problems of the Jacobi-based approach, a new inverse kinematics modeling approach has been proposed that approximates the inverse kinematics of a robot class with a hyperredundant continuum, namely the compact bionic processing assistant (CBHA). Neural network and radial basis multilayer perceptron (MLP) function as an approximation method. Validation using a rigid industrial manipulator with 6 degrees of freedom demonstrates the effectiveness and efficiency of the proposed method [15].

2. Research on the Quality Diagnosis of Teaching Archives Management from the Perspective of Collaborative Education

2.1. Background of Quality Diagnosis of Teaching Archives Management. With the continuous development of science and technology and the rapid development of the social economy, information management has gradually become an essential part of our daily life and work processes. Manage students' learning file information, completely liberate teachers from the traditional complex manual management stage, greatly improve teachers' work efficiency, and help students understand their learning status in real time. It is an important part of education management in social schools and training institutions. It is a database where managers can formulate appropriate management strategies. Real-time visibility into student learning is also an important benchmark for employee education. However, universities mainly implement the management of teaching files through manual methods. Obviously, there are too many limitations in this way of working, such as clumsy access, high storage costs, poor confidentiality, and difficulty in updating data. With the successive progress of message management technology, computer information management plays a significant role in the management of students' learning files. Using a computer to manage student course files has unparalleled advantages over manual file information management, for example, fast search speed, high security, large storage capacity, easy management, easy maintenance, and low cost as shown in Figure 1.

With the continuous advancement of science and technology and the rapid development of the social economy, message management has gradually become an inseparable part of our daily life and work process. The information management of students' teaching file information completely liberates teaching workers from the traditional and complex manual management stage, greatly improves the work efficiency of teaching workers, and also facilitates students to understand their learning status in real time. Teaching file management is a very important link in the management of schools and training institutions in society. It is very important for both school managers and teaching workers. It is the data basis for managers to formulate relevant management strategies. It is also an important reference for teaching workers to grasp the learning status of students in real time.

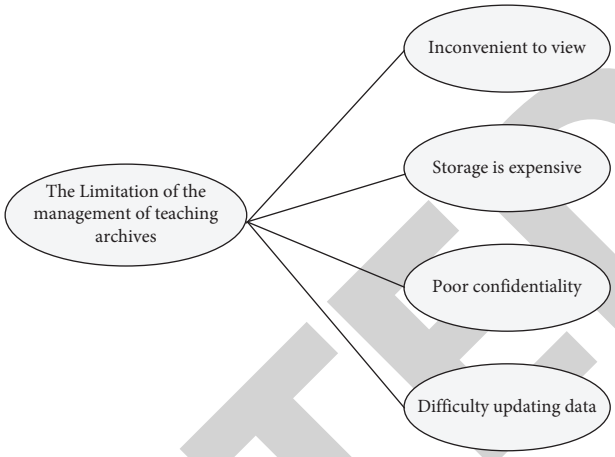

Figure 1: Limitations of teaching archives management.

2.2. Diagnosis of the Quality of Teaching Archives Management. According to the traditional method, the student learning file manager needs to create a paper version file for each student, which is not easy to save and whose security is not high. At the same time, paper files require a large amount of paper, which wastes resources. At the same time, the storage environment of paper files requires high requirements, which may cause file damage. Paper versions of documents are not conducive to finding and changing information. If you change the student profile information, you will need to modify the original profile information. The paper version of the document is not conducive to finding the document, and in the process of modifying the information, errors may occur, causing problems with the cleanliness of the entire document. The paper version of the document is not conducive to the statistical analysis of teachers or archivists. It can even be said that the paper version of the document has no statistical analysis function. Trying to find out the rules in the huge archives may be considered an impossible task. However, the problems existing in the traditional management of student status can be well solved by the method of bionics. The problem proposed in this paper is only to investigate and analyze on the basis of diagnosing the quality of student status:

(1) The student teaching file manager must establish a paper version of the file for each student. The paper version is not easy to store and has low security.

(2) The paper version of the file is not conducive to the query and the modification of information.

(3) Errors may occur in the process of information modification, so there are problems with the neatness of the entire file. The paper version of the file is not conducive to the statistical analysis of teachers or file managers.

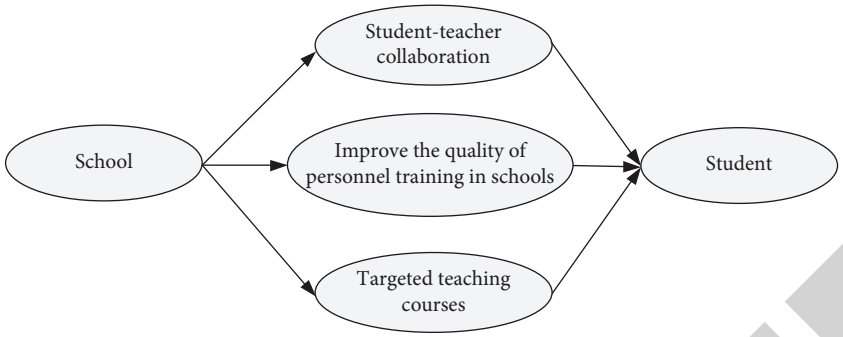

Figure 2: Influence mechanism of collaborative education on teaching.

2.3. Significance from the Perspective of Collaborative Education. By increasing the school's participation in collaborative learning and deepening the collaboration between teachers and students, it is beneficial for schools to set up courses, formulate courses, write teaching materials, improve internal and external training bases, and hire frontline technical and technical experts from enterprises for training. Pass on school practical skills to effectively improve the training quality of school staff through the systematic acquisition of theoretical knowledge and practical skills to ensure that students meet the needs of the industry and enterprises for technical and skilled talents, effectively reducing the time for students to adapt to jobs, and cultivate industrial enterprises and the truly skilled people that society needs. As an innovative talent training method, school-enterprise cooperative education is an important part of the development of vocational education. This study analyzes the quality of teaching document management at the current stage to diagnose the degree of collaboration, find out the factors that affect the degree of collaboration, and propose remedial measures to improve the degree of collaboration, so as to inspire schools to implement in-depth collaborative education and cultivate talents and talent industries that are more suitable for the market economy. It provides an effective way for schools to cultivate a large number of high-quality engineering and technical talents through collaborative education. The government has always attached great importance to the development of higher education, ignoring the importance of quality educational archive management. However, with the reform of the education system and the transformation and modernization of the social economy in recent years, the government, enterprises, and schools have gradually realized the important role of education archives management quality diagnosis in social and economic development. The education and training model helps to better understand the diagnosis of the quality of educational archives by enterprises of all backgrounds and schools and the collaborative education and training model, and promotes the development of the collaborative education and training model, as shown in Figure 2:

(1) It is beneficial for schools to set up courses according to the specific requirements of theoretical knowledge and vocational skills for students in relevant majors

(2) Effectively improve the quality of talent training in schools and cultivate skilled talents needed by industry, enterprises, and society

(3) Promote the school to achieve deep-level collaborative education and provide an effective path for cultivating batches of high-quality technical and skilled talents

2.4. Diagnosis and Optimization of Teaching Archives Management Quality from the Perspective of Collaborative Education. Business process optimization refers to the improvement of unreasonable or complex parts of the original business process. Its main purpose is to simplify the processing process in the system, improve the efficiency of the use of existing resources, and the work efficiency of key personnel. The computerization of file management makes the entire process more convenient, saves unnecessary troubles that may be caused by the repeated transmission of paper documents in primary business process management, and makes it easier to find and modify information, reducing information management costs. Information storage is more secure and reliable, reducing unnecessary risks. At the same time, compared with the original management process, the system has added a statistical function, and administrators can generate various statistical reports as needed to better understand student information, facilitate various teaching tasks, and classify a student's course information. Therefore, the classification of information is no longer so simple, and the management and storage of information are more convenient. Compared with business management, the new business process adds a statistical function to help file administrators better understand student course information and facilitate the development of teaching work. The management of the company has added a statistical function, and the file administrator can better understand the students' course information, which is very helpful for the development of teaching work. Students, teachers, and archivists can easily find and create statistics on student performance data. By changing the classification of students' grade information, information classification is no longer so easy, and information management and storage are more convenient. Each teacher is solely responsible for the grades in the courses he or she teaches. The addition of the statistical

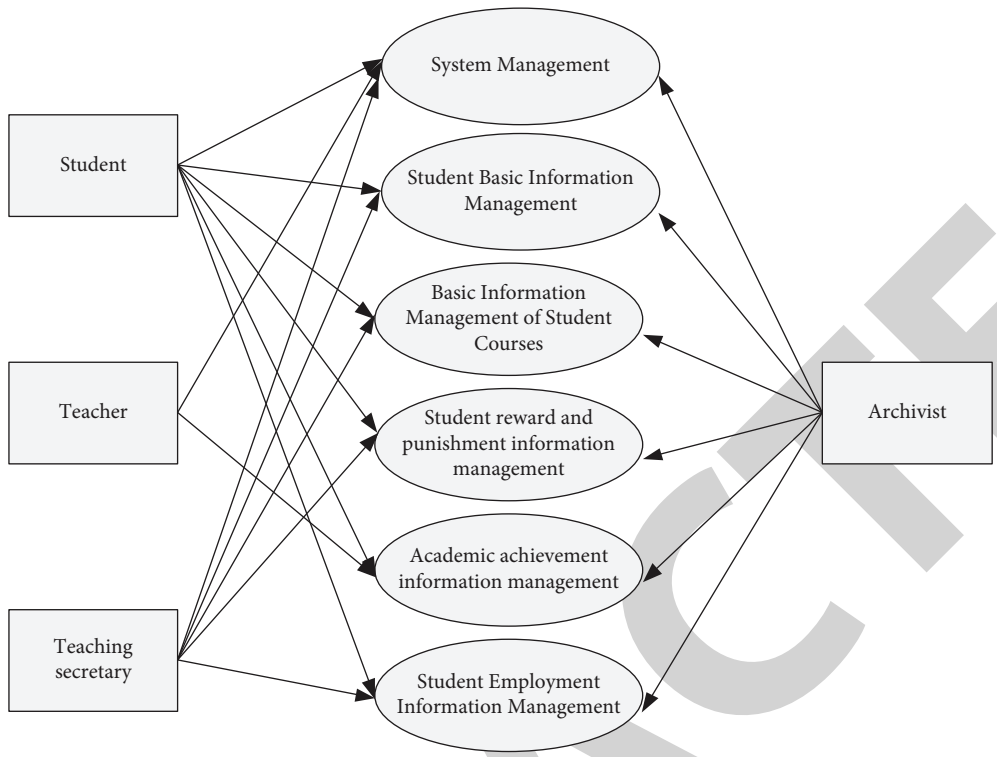

Figure 3: Overall use case diagram of the teaching file management system.

function makes the management of student performance more intuitive and convenient. Students can easily request and view their employment information; employment teachers can easily view student employment information; and it is more convenient to view difficult-to-assess information, and only need to log in to view and correct the relevant information. Sufficient information avoids the tedious process of modifying information in paper documents. At the same time, the classification of employment information is more diverse, which is convenient for different employees to search according to different needs, which greatly facilitates the search, modification, and storage of information and effectively reduces the burden on business personnel and improves work efficiency, as shown in Figure 3.

The informatization of file management makes the whole process more convenient, saves the unnecessary trouble that may be caused by the transmission of paper documents many times in the original business process management, and makes the query and modification of information more convenient, reducing the cost of information management and making the preservation of information more secure and reliable, and unnecessary risks are also reduced. In addition, compared with the original management process, the system has added a statistical function. The administrator can generate different statistical reports according to the needs for better understanding the information of the students, and the students can also easily query.

3. Biomimicry-Based Methods

3.1. Traditional Detection Technology. For the sake of simplicity, it is assumed that the channel is synchronized, the carrier phase is zero, the multipath effect is not considered, and the system modulation mode is BPSK mode. Assuming that there is a user K in the system, the baseband expression obtained is given as follows:

$$r(t) = \sum_{k=1}^{K} A_k(t) g_k(t) d_k(t) + n(t), \tag{1}$$

where $A_k(t)$ is the signal amplitude of the k-th user, $d_k(t)$ is the information bit value of the k-th user, $d_k(t)$ is the characteristic sequence of the K-th user, T_b is the time width of the information bit, $n(t)$ is the additive white Gaussian noise. The spectral density is $N_0/2\,(W/\mathrm{Hz})$.

$A_k(t)$, $d_k(t)$, $d_k(t)$, T_b, $n(t)$, $N_0/2\,(W/\mathrm{Hz})$ For the sake of simplicity, it is assumed that the channel is synchronized, the carrier phase is zero, the multipath effect is not considered, and the system modulation mode is BPSK mode. Assuming that there is a user K in the system, the baseband expression obtained is given as follows:

$$\rho_{i,k} = \frac{1}{T_b} \int_{T_b} g_i(t) g_k(t) \mathrm{d}t. \tag{2}$$

If $i = k$, then $\rho_{i,k} = 1$; if $i \neq k$, then $0 \leq \rho_{i,k} \leq 1$.

The output of the k-th channel of the matched filter bank in a certain symbol interval is given as follows:

$$\begin{aligned} y_k &= \frac{1}{T_b}\int_{T_b} r(t)g_k(t)\mathrm{d}t \\ &= A_k d_k + \sum_{\substack{i=1\\ i\neq k}}^{K} \rho_{i,k}A_i d_i + \frac{1}{T_b}\int_{T_b} n(t)g_k(t)\mathrm{d}t \\ &= A_k d_k + MAI_k + z_k. \end{aligned} \tag{3}$$

The first term in equation (3) is caused by the autocorrelation of the kth user signal, which is a useful term; the second term is caused by the cross-correlation between the signals of other users and the kth user signal, which is multiple access interference; and the third term is noise.

The traditional detector is actually a filter-matched detector, which is handled by each user independently without considering the influence of other users, which is simple and easy to implement. The traditional filter matching receiver is the optimal receiver for a user in the additional channel of the Gaussian white noise, and the multiple access interference is obviously not a Gaussian distribution, so the performance of the traditional receiver in the system is not optimal, and there is multiple access interference, distraction, and close-up effects. At the same time, since this is an interference-limited system, the magnitude of the interference directly affects the throughput of the system, so how to effectively overcome and suppress multiple access interference and near-field effects has become a major problem for the system. In order to solve the problem of multiaccess interruption and short-range effect in the current system, multiuser detection technology emerges as the times require.

The traditional detector is actually a matched filter detector; each user is processed separately, and the influence of other users is not considered, which is simple and easy to implement. The traditional matched filter receiver is the optimal receiver in the single-user additive white Gaussian noise channel, and the multiple access interference is obviously not a Gaussian distribution, so the performance of the traditional receiver in the system is not optimal, and there are multiple access interference and near-far effects.

A matched filter plus the Viterbi algorithm to obtain the maximum probability of sequence detection applies to a given channel. The detector can achieve the theoretical minimum error probability. It adopts the principle of maximum a posteriori probability, so it is a maximum probability estimation algorithm. The algorithm formula is given as follows:

$$[b_1,\cdots,b_k] = \arg\max_{b_1,\cdots,b_k} \exp\left(-\frac{1}{2\sigma^2}\int_0^T \left[r(t) - \sum_{k=1}^{K} A_k b_k s_k(t)\right]^2 \mathrm{d}t\right). \tag{4}$$

Equation (4) is equivalent for making

$$\begin{aligned} J(b) &= 2\int_0^T \left[\sum_{k=1}^{K} A_k b_k s_k(t)\right] r(t)\mathrm{d}t - \int_0^T \left[\sum_{k=1}^{K} A_k b_k s_k(t)\right]^2 \mathrm{d}t \\ &= 2b^T Ay - b^T Hb. \end{aligned} \tag{5}$$

Maximize

$$\begin{aligned} y^{\mathrm{def}} &= [y_1,\cdots,y_K]^T, \\ A^{\mathrm{def}} &= \mathrm{diag}[A_1,\cdots,A_K], \\ H^{\mathrm{def}} &= \mathrm{ARA}, \end{aligned} \tag{6}$$

where R is the normalized cross-correlation function.

$$y_k = \int_0^T s_k(t)r(t)\mathrm{d}t. \tag{7}$$

In the asynchronous case, it is only necessary to generalize the probability function of the synchronous channel. In particular, the probability function should be computed as follows:

$$\begin{aligned} &f[\{r(t), t\in[-MT, MT+2T]\}|b] \\ &= \exp\left(-\frac{1}{2\sigma^2}\int_{-MT}^{MT+2T} [r(t) - S(t,b)]^2 \mathrm{d}t\right). \end{aligned} \tag{8}$$

Maximize, where

$$S(t,b) = \sum_{k=1}^{K}\sum_{i=M}^{M} A_k b_k[i] s_k(t - iT - \tau_k). \tag{9}$$

Let A_M be a $K(2M+1)\times K(2M+1)$ diagonal matrix, where $k+iK$ diagonal elements are equal to A_k; A_k write

$$v_{k+iK}(t) = s_k(t - iT - \tau_k), \tag{10}$$

and define

$$r_{i,j} = \int_{-\infty}^{\infty} v_i(t)v_j(t)\mathrm{d}t. \tag{11}$$

Let R be the $K(2M+1)\times K(2M+1)$ matrix whose elements are r_{ij}, the matrix R can be written as follows:

$$R = \begin{bmatrix} R[0] & R^T[0] & 0 & \cdots & 0 & 0 \\ R[1] & R[0] & R^T[1] & \cdots & 0 & 0 \\ 0 & R[1] & R[0] & \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & R[1] & R[0] \end{bmatrix}. \tag{12}$$

We define

$$H = A_M R A_M. \tag{13}$$

The maximization of equation (13) is equivalent to choosing b such that

$$\begin{aligned} J(b) &= 2\int_{-MT}^{MT+2T} S_i(b)y(t)\mathrm{d}t - \int_{-MT}^{MT+2T} S_i^2(b)\mathrm{d}t \\ &= 2b^T A_M y - b^T \mathrm{Hb}. \end{aligned} \tag{14}$$

Since the boundary values used in the maximization function in the usual optimal decision equation (14) are derived only from the fitted filter, y is a sufficient b statistic.

Although it has been proved theoretically that the detection with the maximum probability can approach the

receiving performance of a single user and effectively overcome the short-range effect, the complexity of the Viterbi algorithm is the exponential power of 4 user numbers, namely A. The detector needs to know the amplitude and phase of the received signal, which can be obtained by estimation. Therefore, it is necessary to find a suboptimal multiuser detector that is relatively simple to compute.

Immunoselection is usually performed in two steps. The first step is to test the immune system, which means test the vaccinated individuals. If the conditions are not as good as the parents, it means that there has been serious degradation in the process of hybridization and mutation. At this point, the individual is replaced with a suitable individual in the parental generation, and the second step is the selection of annealing, that is, the probability of having B in the current population.

$$P(x_i) = \frac{e^{f(x_i)}/\mathrm{T}_k}{\sum_{i=1}^{n_0} f(x_i)/T_k}. \tag{15}$$

3.2. Adaptive Immune Algorithm. The immune operator consists of two parts: vaccination and immune selection. Vaccine refers to the basic feature information derived from people's more or less prior knowledge of the problem. However, when solving practical problems, two situations often occur: on the one hand, it is difficult to form relatively mature prior knowledge when solving problems, and relevant feature information cannot be extracted from the analysis process; effective immune vaccines are obtained; on the other hand, the cost of finding the local solution of the global solution is larger than the appropriate ratio, which increases the computational cost, reduces the efficiency, and makes the work of extracting vaccines meaningless.

In order to improve the generality and ease of use of the algorithm, we adaptively extract effective information from the genes of the best individuals during the evolution of the population and then create an immune vaccine. At the same time, in the vaccination campaign, the adaptation parameter p_1 is introduced, which represents the percentage of the number of people vaccinated. As algebra p_1 increases, it eventually increases to 1, which means that all individuals are vaccinated, so later in evolution, the algorithm is characterized by a large number of local mountaineering searches. Since the ratio of vaccines and vaccinees is adaptively changed in the algorithm for extracting immune vaccines, this algorithm is called an adaptive immune algorithm. In addition, in the above immune selection, we further improved the annealing selection formula, which in the algorithm is actually a survival strategy realized by competition between offspring and parents. At a given temperature value T, child C replaces parent P with the next probability p.

$$p = \frac{1}{1 + \exp\left(F(C) - F(P)/(T_k)\right)}. \tag{16}$$

Among them, $\alpha = 0.05$ can be obtained from Formula (16), at a sufficiently high temperature, the immune selection is random, so the search process represents a random search; at a sufficiently low temperature, efficient individuals are selected, turning the search process into a deterministic mountaineering search. After the ant has completed n cycles, the new information left on each path traveled by the last ant must be added to τ_{ij} before the next cycle. The amount of information should be adjusted according to the following formula:

$$\begin{aligned} \tau_{ij}(t+n) &= \rho\tau_{ij}(t) + \Delta\tau_{ij}, \\ \Delta\tau_{ij} &= \sum_{k=1}^{m} \Delta\tau_{ij}{}^{k}, \end{aligned} \tag{17}$$

where ρ is the information residual factor. By imitating the characteristics of human memory, the old information will gradually disappear and the remaining information will gradually disappear over time, and the parameter $1-\rho$ is used to represent the degree of information attenuation, that is, the degree of fluctuation. $\Delta\tau_{ij}{}^{k}$-The amount of information $\Delta\tau_{ij}$ left on paths i to j over a period of time in this cycle. D-represents the increase in the amount of information left on paths i to j by all ants that may pass $i \Leftrightarrow j$ in this cycle.

4. Diagnosis and Analysis of Teaching Archives Management Quality from the Perspective of Collaborative Education Based on Bionics

4.1. Construction of Quality Diagnostic Indicators of Teaching Archives Management from the Perspective of Collaborative Education. In order to study the quality diagnosis of teaching archives management from the perspective of collaborative education, it is necessary to analyze the indicators of teaching archives management and obtain the research results by calculating the obtained data. This paper establishes six indicators, namely, hardware environment, security requirements, system maintenance, user interface, information flow, and accuracy. These six important indicators are screened and analyzed accordingly, as shown in Table 1.

It can be seen from the figure below that the indicator layer is relatively important for the quality diagnosis of teaching file management, and only a few think it is not important. Among them, the most important number of people selected for security requirements is 201; the number of important people selected for system maintenance is less than other indicators; the number of people is 176; so, the indicators meet the standards of experimental indicators, as shown in Figure 4.

4.2. Bionic Approach. The data set used in the experiment is classified into statistical categories. The number of features of the hardware environment is 8, the number of samples is 768, and the number of categories is 2; the number of features required by security requirements is 13, the number of samples is 178, and the number of

Table 1: Construction of the index system.

Target layer	Indicator layer
Quality diagnosis of teaching archives management from the perspective of collaborative education	Hardware environment Safety requirements System maintenance User interface Information flow Precision

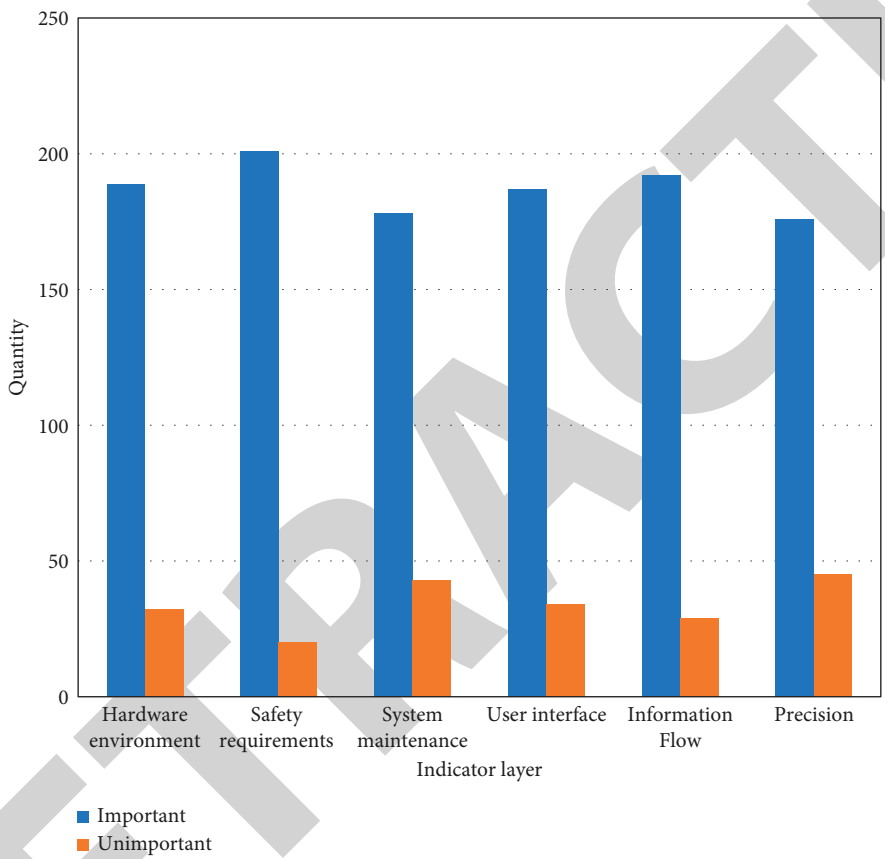

Figure 4: Importance of index layer.

Table 2: Datasets used in the experiments.

Indicator layer	Number of features	Number of samples	Number of categories
Hardware environment	8	768	2
Safety requirements	13	178	3
System maintenance	19	846	4
User interface	60	208	2
Information flow	34	351	2
Precision	4	150	3

categories is 3; the number of features required for system maintenance is 19, the number of samples is 846, and the category is 4; the number of features of the user interface is 60, the number of samples is 208, and the number of categories is 2; the number of features of the information flow is 34, the number of samples is 351, and the number of categories is 2; the number of accuracy is 150, the number of samples is 4, and the class is 3, as shown in Table 2.

It can be seen from the columns in Table 3 and Figure 5 that under the PsoKnn method, the quality diagnosis accuracy of the user interface is the lowest, with an accuracy of 64%; the accuracy of the quality diagnosis is the highest, with an accuracy of 96.67%; under the C4.5 method, the system maintenance. The accuracy of system maintenance quality diagnosis is the lowest, with an accuracy of 68.44%; the accuracy of quality diagnosis is the highest, with an accuracy of 96%; under the GGAKNN method, the quality diagnosis

Table 3: Comparison of experimental results of bionic methods.

	PsoKnn (%)	C4.5 (%)	GGAKNN (%)
Hardware environment	76.15	75	77.53
Safety requirements	94.12	93.82	98.95
System maintenance	74.52	68.44	76.82
User interface	64	73.56	94.29
Information flow	88	89.40	90.28
Precision	96.67	96	98.67

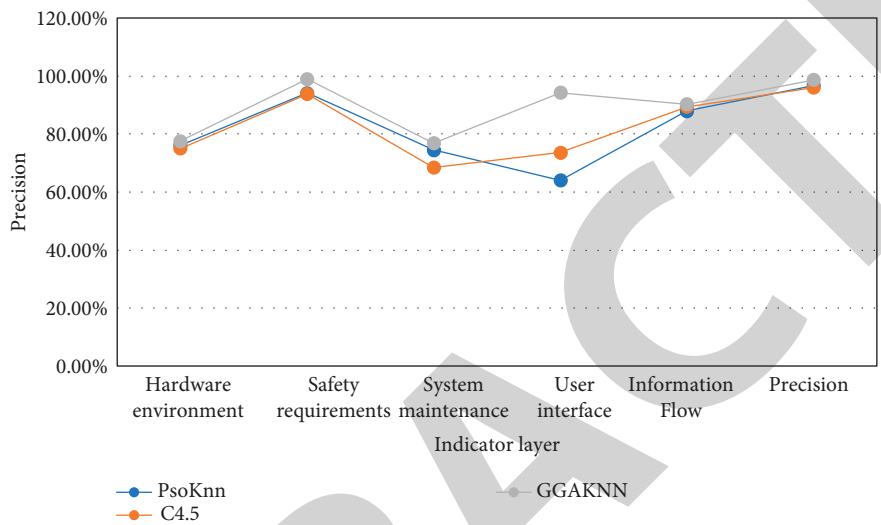

Figure 5: Accuracy comparison of bionic methods.

accuracy of the system maintenance is the lowest, with an accuracy of 76.82%. The accuracy is 98.95%; it can be seen from the line that in the hardware environment, the accuracy of the three bionic methods is about 75%; the accuracy of GGAKNN is the largest; the accuracy is 77.53%; the accuracy of C4.5 is the smallest; the accuracy is 75%. In the safety requirements, the accuracy of the three bionic methods is about 93%; the accuracy of GGAKNN is the largest; the accuracy is 98.95%; the accuracy of C4.5 is the smallest; the accuracy is 93.82%. In the system maintenance, the accuracy of the three bionic methods is all around 70%; GGAKNN has the highest accuracy with an accuracy of 76.82%, and C4.5 has the smallest accuracy with an accuracy of 68.44%. In the user interface, the accuracy of the three bionic methods differs significantly, and GGAKNN has the highest accuracy with an accuracy of 94.29%. PsoKnn has the smallest accuracy, with an accuracy of 64%. In the information flow, the accuracy of the three bionic methods is all around 89%. GGAKNN has the largest accuracy with an accuracy of 94.29%, and PsoKnn has the smallest accuracy with an accuracy of 88%. In terms of performance, the accuracy of the three bionic methods is around 97%. The accuracy of GGAKNN is the largest with an accuracy of 98.67%, and the accuracy of C4.5 is the smallest with an accuracy of 96%. As shown in Table 3 and Figure 5.

In the precision rate, the user interface is the highest, with a precision rate of 88.18%, followed by accuracy, security requirements, hardware environment, system maintenance, and information flow. Among the precision rates, security requirements are the highest, with a recall rate of 89.09%, followed by the hardware environment, accuracy, user interface, information flow, and system maintenance. In F1, the user interface is the highest at 89.05%, followed by the hardware environment, information flow, accuracy, security requirements, and system maintenance, as shown in Figure 6.

4.3. Particle Swarm Optimization Coverage Algorithm. Under the PSONCA method, the highest accuracy is the security requirements, with an accuracy rate of 96.11%; the lowest accuracy rate is the hardware environment, with an accuracy rate of 71.56%; followed by the user interface, information flow, accuracy, and system maintenance. The largest number of coverages is the system maintenance, covering 302 digits; the least is security requirements, covering 19 digits; followed by hardware environment, information flow, user interface, and accuracy. The largest number of rejected samples is in the hardware environment, with 28. The least is security requirement number 1, followed by system maintenance, accuracy, information flow, and user interface. The most correct number of rejection samples is in the hardware environment, followed by system maintenance, information flow, accuracy, user interface, and security requirements, As shown in Table 4.

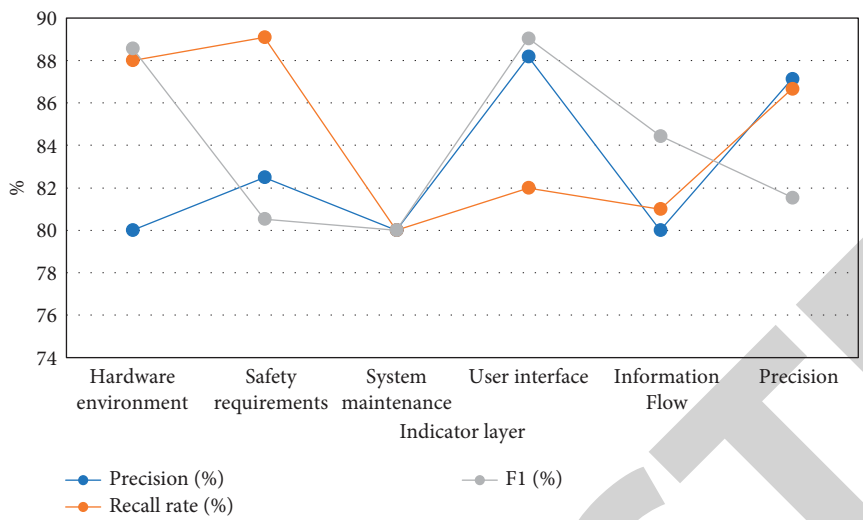

Figure 6: Data experimental results.

Table 4: Experimental results of PSONCA.

	Hardware environment	Safety requirements	System maintenance	User interface	Information flow	Precision
Accuracy (%)	71.56	96.11	81.18	95.24	92.22	90.12
Coverage	205	19	302	53	76	26
Number of rejected samples	28	1	15	3	6	10
Rejection sample identification correct number	17	1	8	2	6	5

Table 5: Experimental results of NCA.

	Hardware environment	Safety requirements	System maintenance	User interface	Information flow	Precision
Accuracy (%)	70.26	95	78.82	95.24	90.83	89.62
Coverage	308	23	254	63	89	69
Number of rejected samples	7	2	30	6	10	9
Rejection sample identification correct number	4	1	15	4	8	6

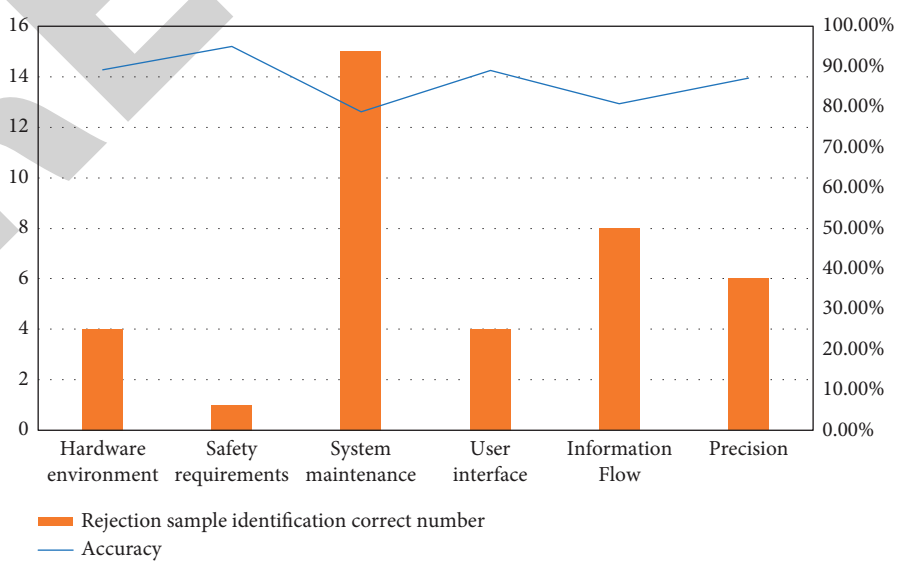

Figure 7: Indicator accuracy rate.

Under the NCA method, the user interface has the highest accuracy rate, with an accuracy rate of 95.24%; the hardware environment has the lowest accuracy rate, with an accuracy rate of 71.56%; followed by security requirements, information flow, accuracy, and system maintenance. The most covered is the hardware environment, covering 308 digits; the least covered is security requirements, covering 23 digits; followed by system maintenance, information flow, user interface, and accuracy. The largest category of rejection samples is system maintenance, with 30; the least is security requirements, with 2; followed by accuracy, information flow, and user interface. The highest number of correct identifications of rejection samples is in system maintenance, followed by information flow, accuracy, user interface, and security requirements, as shown in Table 5.

As can be seen from the figure below, the more correctly the number of rejected samples is identified, the lower the accuracy of the indicator. The number of correct identifications of rejection samples maintained by the system is the most, and its accuracy is the smallest index, with an accuracy rate of 78.82%; the number of correct identifications of rejection samples in the information flow is 8, and the accuracy rate is 80.83%. The accurate identification of rejection samples is correct. The number is 6, and the accuracy rate is 87.1%; the number of correct identifications of rejection samples in the user interface is 4, and the accuracy rate is 89.1%; the number of correct identifications of rejection samples in the hardware environment is 4, and the accuracy rate is 89.26%. The number of correct sample recognitions is 1, and the accuracy rate is 95%, as shown in Figure 7.

5. Conclusion

In today's rapid development of social informatization, the application of computerized management technology continues to penetrate into all fields of social life. Managing information from students' educational files is a concrete manifestation of the application of information management technology, which brings great convenience to teachers. Therefore, more and more people begin to develop more practical case management systems in student education, and more and more developers begin to develop file management systems for specific scenarios. On the one hand, it can provide a policy basis for school administrators, and on the other hand, it can greatly improve the work efficiency of staff so that system users can conveniently and quickly search and count student information and other related work. Analyze the data that needs to be processed by each function of the system, and propose the direction of improving the management of educational archives. The indicators are analyzed by bionic methods. Under one method, the quality diagnosis accuracy of system maintenance is the lowest, with an accuracy of 68.44%; the accuracy of quality diagnosis is the highest, with an accuracy of 96%. The system's maintenance can be upgraded and improved. Under the PSONCA method, the highest accuracy is the security requirement, and the lowest accuracy is the hardware environment, so the hardware environment needs to be improved.

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 declare that they have no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Research on Value Co-Creation New Business Model of Import Cross-Border E-Commerce Platform Ecosystem

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] C. Peng, X. Jing, J. Tie et al., "Research on Value Co-Creation New Business Model of Import Cross-Border E-Commerce Platform Ecosystem," *Security and Communication Networks*, vol. 2022, Article ID 8726075, 14 pages, 2022.

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Research Article

Research on Value Co-Creation New Business Model of Import Cross-Border E-Commerce Platform Ecosystem

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Since the outbreak of COVID-19, the cross-border e-commerce platform has been rising rapidly because of its unique advantages. However, with the widespread application of information technologies such as mobile Internet and big data, fundamental changes have taken place in consumer preferences, consumption patterns, and marketing channels in cross-border e-commerce platforms. They also change the logic of value co-creation (VCC). The platform can achieve survive, expansion, and sustainable development by realising the value co-creation of the whole platform ecosystem. Based on the perspective of the platform ecosystem, this paper uses the grounded theory analysis method and NVivo 11.0 software carries out three-level coding on the obtained original data, and finally summarises and extracts four core categories of value co-creation mechanism: connection and interaction of value co-creators, demand mining, resource integration, and system support. The first two categories reflect stakeholders' internal connection and interaction mechanism, and the last two categories reflect the external support mechanism in value co-creation.

1. Introduction

The COVID-19 pandemic has swept the world since the beginning of 2020, and the outbreak has had a significant impact on cross-border trade. The World Trade Organization (WTO) has predicted that global trade will collapse in 2020, even the most serious after World War II. The WTO also predicted that the growth rate of Global trade would be only about 7.2% in 2021, much lower than the 21.3% rebound previously predicted. These data are derived from the trade statistics and Outlook report. The latest statistics report shows that in 2020, the value of world commodity exports decreased by 8%, while service trade contracted by 21% [1]. In this case, the traditional offline trade channels face the problem of "financial interruption" failure. At the same time, the new cross-border e-commerce platform relies on the Internet. The rapid rise of new cross-border e-commerce platforms relying on technologies such as the Internet, artificial intelligence, big data, and cloud computing has become the key to maintaining global trade during the epidemic.

Cross-border e-commerce can break through the limitations of time and space. It can meet the increasingly personalised needs of consumers. Especially during the epidemic, it can reduce body contact during the trade process, promoting the rapid transformation of international trade mode with its unique advantages. However, due to the shrinking global demand and the strengthening of trade barriers in various countries, market competition has become increasingly fierce. During this period, many cross-border e-commerce companies could only strive for the market through price advantages, which led to serious business model duplication and product homogeneity. In addition, the ultra-low profit rate, low customer satisfaction, and loyalty have caused a series of problems in cross-border e-commerce companies, such as poor operational sustainability and a short life cycle. According to a report released by the China E-commerce Research Center, 13 cross-border e-commerce companies will have closed down in China in 2020, and this number may be expected to continue to rise in 2021 [2]. Therefore, cross-border e-commerce companies must form a new model of the platform ecosystem that centres on platform companies and gathers supply-side, demand-side, and other stakeholders. For cross-border e-commerce companies to achieve sustainable development,

they need to achieve two points: 1. Form a platform ecosystem that centres on platform companies and gathers supply-side, demand-side, and other stakeholders. 2. Break the traditional single corporate value creation model, then apply multistakeholders' VcC new model.

However, the current research on the value co-innovation model of the cross-border e-commerce platform ecosystem is at the initial stage of theoretical construction. These studies cannot meet the needs of business practice development. In addition, Storbacka and Brodie [3] think the value co-creation (VcC) mechanism of the platform ecosystem is still in a "black box" state, which needs to be further explored. Christoph and Paul's [4] research emphasises that VcC is the expected behaviour of different subjects such as suppliers, demanders, and customers, and expands the scope of VcC from the dual scope of customers and enterprises to the scope of business network systems. However, the current related research mainly discusses the VcC among multistakeholders from an innovation network and innovation process. There may be a lack of VcC research on the platform ecosystem as the research object, especially the imported cross-border electricity with many stakeholders. Researchers rarely involve the business platform ecosystem.

The research logic of this article is based on the above theoretical analysis. In addition, to avoid conceptual confusion caused by too many stakeholders when setting the research object, this article takes the import trade model of a cross-border e-commerce platform as the research object. The sample selected representative cross-border e-commerce platforms, such as JD.MALL, and interviewed the three main stakeholders of these platforms, including managers, overseas suppliers, and Chinese consumers. We construct a grounded theoretical model of the multistakeholders' VcC mechanism of the imported cross-border e-commerce platform ecosystem through the original sentence. Use open coding, main axial coding, and selective coding to clarify the VcC path and the VcC of various stakeholders' relationships. Based on this, we find out the critical points of the VcC of the export cross-border e-commerce platform ecosystem and then propose a theoretical plan to build a value co-innovation model.

2. Literature Review

2.1. Cross-Border e-Commerce Platform Ecosystem. With the further development of the Internet economy, academia pays more and more attention to the research of platform organisation form. At present, the academic community has made fruitful achievements in researching platform theoretical basis, platform competition, and platform governance. The platform ecosystem is developed from the business ecosystem and is the specific expression of the business ecosystem. Therefore, scholars primarily extend the existing research on business ecosystems to platform ecosystems.

Moore [5, 6] first proposed the concept of the business ecosystem in 1993, defined it as an economic community composed of multiple interrelated stakeholders, and pointed out that the members of a business ecosystem include customers, suppliers, investors, business partners, trade unions, and government. Kim et al. [7] considered that each enterprise constituting the business ecosystem could create more value than a single enterprise through collaborative cooperation. Iansti et al. [8] also supported Moore's view by comparing other ecosystems with business ecosystems. They defined business ecosystems as a group of loosely connected but necessary system participants who make progress together, value creation, and sharing. After the research on the definition of business ecosystems was relatively mature, more scholars focused on the business ecosystems of impact on other fields (e.g., [9, 10]). Penttil et al. [11] developed an empirical model to analyse the personal managers' sense-making, which is affected by the changing of the business environment and the various stakeholders in that network. Other scholars believe that, in the business ecosystem, the cooperation form and value-sharing mechanism of stakeholders will affect the innovation performance of enterprises. Many scholars have put the business ecosystem theory into cross-border trade in recent years [12]. Cha [13] constructed a method to promote the quality of global trade strategic governance of multinational corporations by using the business ecosystem theory. Tomas et al. [14] applied the Uppsala model to the ecosystem of the cross-border business platform, which provided a new marketing theory for the trade model.

With the in-depth study of the platform ecosystem, the relationship with sustainable commercial development is more and more inseparable. Chen et al. [15] and others believed that the business ecosystem could provide a new perspective for modern enterprises, and combined with FAHP method, and they further put forward the symbiosis and evolution scheme of bionic systems and conclude that enterprises can benefit from the platform and promote the growth of the whole ecosystem. Rong et al. [16] pointed out that the stakeholders in the business ecosystem can be closely or loosely coupled. They should cooperate and compete and jointly develop new products or services around the theme of innovation to meet customers' needs. Li [17] proposed that the business ecosystem goes beyond market positioning and enterprise organisation. It embodies three main characteristics: symbiosis, platform, and collaborative evolution. As a part of the business ecosystem, the platform ecosystem is a more complex ecosystem composed of platform enterprises, suppliers, demands, and other stakeholders. The realisation of VcC also depends on a good platform ecosystem environment. Other scholars have studied the platform ecosystem from the perspective of Ecological Symbiosis Theory and believe that the symbiotic environment is an essential external condition to promote the evolution of the cross-border e-commerce ecosystem. By continuously optimising the ecosystem, we provide primary conditions for the sustainable and stable development of cross-border e-commerce platforms [18]. Wei et al. [19] focused the research on the service recovery effect of the online platform ecosystem. The research revealed that the emotional intelligence of platform employees has a positive impact on the relationship quality between customers and

service providers and has a positive impact on the relationship quality between customers and online platforms. Jarkko et al. [20] and other scholars found that the infrastructure for building the ecosystem of e-commerce platform includes digital infrastructure and tools, which can provide information retrieval and networking helps to network agents, company representatives, and researchers, to promote the synergy and stability of the platform ecosystem. Kim [21] also focused the research on the e-commerce platform ecosystem. The research interviewed relevant personnel of 12 cases through 30 in-depth interviews and two focus group interviews to obtain primary data and put forward the conceptual framework of "12 different types of quality management and revenue structure strategies." Mukhopadhyay et al. [22, 23] believe that the cooperation of various stakeholders in the platform ecosystem can promote products' development efficiency and provide strong support for the success of disruptive business platforms. Recent perspectives on the platform ecosystem are shown in Table 1.

2.2. VcC Theory of e-Commerce Platform. As a new research field in recent years, VcC has been developed by more and more scholars. Theoretically, there is no unified definition of VcC. Gummesson et al. [24, 25] believed that it is not enough to only focus on the dual relationship between enterprises and customers but also recognise the diversity of participants involved in the process of value creation. Different studies describe VcC as an activity in which consumers participate. VcC behaviour exists in the process of service and innovation, which expands the value chain and the scope of the activity (e.g., [26–28]). Gummesson and Mele [29] divide the whole process of VcC into two stages: consumer enterprise interaction and resource integration.

In recent years, VCC has attracted the attention of researchers as an emerging field of research. In theory, there is no single definition of VCC. Gummesson et al. argued that focusing only on the one-to-one relationship between a company and its customers is not sufficient, and acknowledging the diversity of actors involved in the value creation process is not sufficient. Several studies describe venture capital as a customer-related activity. The essence of VCC is a service and innovation process that spans the value chain and scope.

From the connotation and characteristics of VcC studied by different scholars, they all emphasise the role of stakeholders in expanding interaction in VcC, especially the critical role of customers' participation in VcC. In the process of VcC, customers realise the transformation from consumer identity to creator identity by re-configuring their roles [30]. Leone et al. [31] studied how different artificial intelligence solutions help suppliers carry out value creation activities with B2B e-commerce platforms. Saarijarvi et al. [32] pointed out that the roles of customers and enterprises are constantly changing and the "creation" of value creation. It re-configures the traditional roles between customers and enterprises to use their resources in new ways and focuses on how to participate in the enterprise value creation process through customer resources to enhance the influence of VcC continuously. Scott et al. [33] found that the probability of salespeople renewing the VcC contract between enterprises depends on the strategy provided by the service department and its interaction and communication with customers.

With the increasingly prominent role of VcC in the sustainable development of commercial economies, scholars have conducted fruitful research from the perspective of the impact mechanism of VcC. Rong et al. [16] pointed out that the key to the success of the business ecosystem lies in the joint development among stakeholders and the shared creation of customer value, highlighting the importance of VcC to the sustainable development of business. Ramaswamy and Ozcan [34] studied and discussed the basic theoretical framework of the VcC paradigm, linked it with the industrial marketing and procurement literature of hybrid network and system ontology, and then verified the system dynamics through increasing the technology of practitioners to promote the critical business management theory in this field finally. Sales VIV ó et al. [35] conducted an empirical comparison on the sample collection of 77 companies in the Spanish furniture industry. It is considered very meaningful to establish a long-term VCC chain with all business partners, which makes up for the research weakness of VcC in the context of B2B. Solving the VCC problem is conducive to constructing the overall ecosystem of companies and enterprises, both academically and administratively [36].

Moreover, the logic of business environment and ecosystem characterised by jointly creating value is the basic premise to enhance and maintain competitiveness, which is conducive to the joint sustainable development of stakeholders (e.g., [37, 38]). As a platform economy, cross-border e-commerce is related to VcC, but there are few discussions on the VcC mechanism of e-commerce platform stakeholders in the existing research. Mainly few scholars focus on the VcC behaviour of the platform ecosystem. VcC is the only way to develop and upgrade cross-border e-commerce enterprises. It can promote enterprises to subvert the traditional model and move towards the high end of the value chain [39]. Therefore, the joint creation of value among stakeholders under the cross-border e-commerce platform ecosystem has become the primary way to expand its value chain. The discussion on how stakeholders in the cross-border e-commerce platform ecosystem can jointly create value and form a new model for cross-border e-commerce development is an urgent problem to be answered in this paper.

According to the existing literature, the research on platform ecosystems mainly focuses on concept research and influencing factors. The current research on the composition and operation process of the business and platform ecosystems has been relatively mature in terms of concept. In terms of influencing factors, the current research mainly focuses on the impact of the business ecosystem on enterprise innovation, executive behaviour, and cross-border trade. The research on VcC mainly focuses on the concept and co-creation mechanism: in terms of concept, the current research on the concept and components of VcC has been

Table 1: Recent perspectives on the platform ecosystem.

Approach	Authors	Refs
The concept of ecosystem	Moore (1993, 1996)	[5, 6]
	Kim et al. (2010)	[7]
	Iansiti et al. (2004)	[8]
Impact of business ecosystem on other business elements	Shin et al. (2021)	[9]
	Li (2018)	[10]
	Penni et al. (2020)	[11]
	Tsou et al. (2019)	[12]
Cross-border business platform ecosystem	Wei et al. (2021)	[19]
	Cha (2020)	[13]
	Hult et al. (2020)	[14]
	Kim (2016)	[21]
Relationship between platform ecosystem and business sustainable development	Chen et al. (2021)	[15]
	Rong et al. (2018)	[16]
	Li (2009)	[17]
	Visnjic et al. (2016)	[23]

relatively mature. The current research on the dual VcC process and methods between enterprises and customers has been relatively mature in the co-creation mechanism. However, the analysis shows that there is less research on the operation mechanism and stakeholders of the online platform ecosystem, and there is a lack of literature on the VcC of the ecosystem of cross-border e-commerce platforms. This research field is still a "Greenland" to be exploited. Main references of the literature review in platform value co-creation are shown in Table 2.

3. Research Methods

This paper adopts the qualitative research method of grounded theory, and its primary purpose is to establish a theory based on empirical data [40]. Therefore, this study does not have theoretical assumptions but directly starts with the original data obtained from practical observation, summarises the generic concepts and categories related to VcC, and finally rises to theory. This article mainly uses the three coding steps of procedural grounded theory to analyse the original data obtained qualitatively and then uses the analysis conclusions to explore the mechanism and path of VcC of the imported cross-border e-commerce platform ecosystem. The first step is to break up and analyse the original data through open coding, find the concept category from the data, name it, and then get the initial category. The second step is to summarise the initial categories through the central axial coding, discover and establish various connections between the concept categories, and then express the organic relationships between the various parts of the data to obtain the main category. The third step is to filter the existing categories through selective coding. Systematic analysis and selection of "core categories" establish core categories and finally reach theoretical saturation. The second step is to summarise the initial category through axial coding, find and establish various relationships between conceptual categories to express the organic relationship between various parts of the data, and obtain the main category. The third step is to select the "core category" after systematic analysis among all the discovered main categories through selective coding, establish the core category, and finally achieve theoretical saturation. The flow chart of grounded theory research method is shown in Figure 1.

The first step was to decompose and analyse the raw data using open coding, identify conceptual categories from the data, name them, and then derive preliminary categories. The second step consisted of summarizing the initial categories by coding the central axis, identifying and establishing various relationships between conceptual categories, and then identifying organic relationships between different components of the data to obtain the main income. In the third step, the available categories are filtered through the coding selection.

3.1. Sample Selection. This paper selects two representative cross-border e-commerce platform enterprises focusing on import trade in China: JD.MALL international and China Southeast Asia South Asia digital business port. JD.MALL international is the first consumption platform in China that focuses on large-scale import business in an all-around way. Through value creation in the four dimensions of consumption scenario, marketing ecology, quality and service, and investment attraction, JD.MALL International brings consumers a more high-quality and prosperous shopping import experience to create a reliable one-stop consumption platform for imported goods. JD.MALL international uses big data technology to realise its value, and customers and businesses are subjects of the VcC of JD.MALL international platform. China Southeast Asia South Asia digital business port is the largest cross-border e-commerce platform for trade between China and Laos, Myanmar, and other South and Southeast Asian countries. The platform mainly imports valuable commodities from South and Southeast Asian countries, such as fresh fruit, dried fruit and other food products, characteristic beauty products, rubber, and other bulk commodities. The following forms of VcC of the platform could conclude as follows: (1) invite foreign suppliers to hold online and offline seminars to understand

Table 2: Main references of the literature review in platform value co-creation.

Approach	Authors	Refs
The concept of value co-creation	Gummesson (2007, 2008b)	[24, 25]
	Leclercq et al. (2016)	[26]
	Galvagno and Dalli (2014)	[27]
	Ranjan and Read (2016)	[28]
	Gummesson et al. (2010)	[29]
Customer criticality	Saarijärvi et al. (2013)	[32]
	Scott et al. (2020)	[33]
Impact of value co-creation	Rong et al. (2018)	[16]
	Sales-Vivó et al. (2020)	[35]
	Ramaswamy and Ozcan (2020)	[34]
	Goel (2010)	[36]
Cross-border e-commerce and value creation	Lin et al. (2017)	[38]
	Zhang et al. (2021)	[37]
	Xiaodong (2019)	[39]

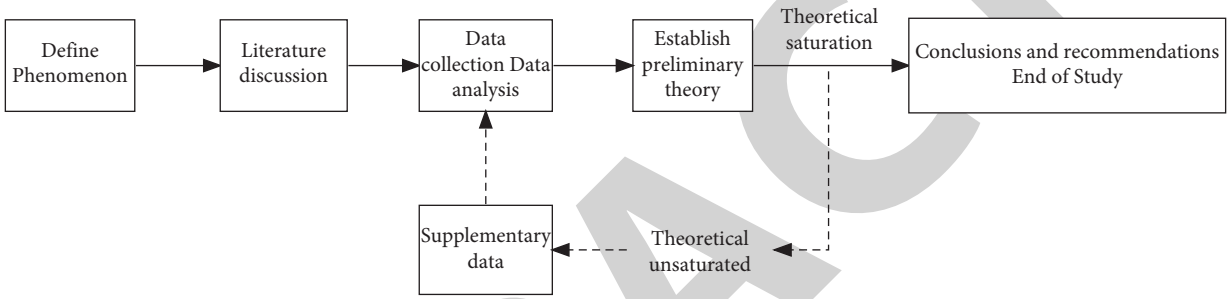

Figure 1: The flow chart of grounded theory research method.

suppliers' demands and discuss platform development planning; (2) increase contact with consumers and understand consumer needs by establishing sales specialists; and (3) the platform, suppliers, and consumers work together to complete each website section's functional improvement and page beautification.

Jingdong Mall International and China Southeast Asia South Asia digital trade port: Jingdong Mall International is the first consumer platform in China that focuses on wholesale import business. Southeast Asia Digital Trade Port Southeast Asia is the largest cross-border e-commerce platform between China and Laos, Myanmar, and other South and Southeast Asian countries.

3.2. Data Collection Scheme. In terms of data and data collection, based on the principle of "everything is data," it is carried out through online and offline interviews, questionnaire surveys, and internal data access. The data collected in this paper include (1) online in-depth interviews with five people from JD.MALL international management; (2) offline in-depth interviews with six people from the management of Yunnan cross-border digital commerce engineering research centre; (3) there are 17 supplier representatives attended the GMS (Greater Mekong Subregion) enterprise Symposium under the enterprise alliance of cross-border e-commerce cooperation platform, mainly from Myanmar, Thailand, Japan, and other countries. They obtained detailed information on the operation of enterprises in different industries and countries on the cross-border platform. At the same time, the research team interviewed seven enterprise leaders and recorded the content. (4) Due to geographical location, a questionnaire was distributed to 20 staff of JD.MALL global purchase business operation Department in China and the contents of the questionnaire were sorted out. (5) Due to a large number of consumers and the biased coverage of in-depth interviews, this study uses the combination of interview and questionnaire to collect consumer-related data. There are 20 interviewees, 123 points of interview questionnaire are distributed, and 87 valid questionnaires are recovered. The interview text is first-hand data rooted in theoretical research. The data collection of this paper mainly relies on personal interviews and questionnaires, which generate sufficient textual data, and then refine concepts and categories from a large number of original sentences.

In order to ensure the systematisation and science of the data analysis process to the greatest extent, this paper focuses on NVivo 11.0 software coding, supplemented by manual coding. A total of three members of the research group participated in the data coding work, sorted out the original materials, including the interview text and survey questionnaire text in the form of meeting, and sorted out the text of more than 10,000 words. On this basis, the coding work is carried out.

4. Modelling Process of VcC Grounded Theory

4.1. Open Coding. This paper uses NVivo 11.0 software to browse and encode the original data to avoid omission. The step-by-step coding of actual data is the core link of grounded theory and the most significant link of quantitative characteristics. Open coding is the first stage of the

coding process, breaking up all the original data, giving concepts, and then recombining and operating them in a new way. Open coding mainly includes several steps: labelling phenomena-discovering genera-naming genera-conceptualising genera [41]. In order to avoid the omission of data, this article uses NVivo 11.0 software to browse-encode the original data. This article first summarised the phenomenon and initially organises the original interview texts sentence by sentence according to the requirements of open coding, and then extracts the original sentences of the expected behaviour of the platform and other parties, and uses these sentences to establish free nodes. We decomposed these nodes into different independent information units and got 136 original sentences, such as: "I think the most important reason a brand can continue to attract me to buy is that the quality can always remain stable." The second is to develop conceptual categories. Due to the large number of concepts formed by the initial coding and the existence of semantic crossover, our research can only abstract the critical information that reflects the connection and interaction of value co-creators through continuous comparison of critical sentences, analysis, and induction them, and then formed 54 initial concepts. For example, the concept of "marketing integration" is abstracted through the original sentence: "At the same time, the platform is also working hard for merchants and enterprises, and constantly using content marketing to attract buyers." The last step is to refine the category. The category is the further refinement of the concept, which is more directional and selective than the concept itself. This step takes a particular concept as the centre, gathers other kinds of concepts in the concept to form a concept group, and then refines the initial category through concept induction. For example, the concepts of "big data technology, questionnaire methods, feedback supervision, postpurchase evaluation, and social platform feedback" are further integrated and included in the category of "demand mining."

Through open coding and combined with relevant literature, this paper abstracts 18 initial categories at this stage, namely, imported cross-border e-commerce platforms and other e-commerce platforms, imported cross-border e-commerce platforms and suppliers, imported cross-border e-commerce platforms and consumers, suppliers and consumers, suppliers, big data technology, questionnaire methods, feedback supervision, postpurchase evaluation social platform feedback, export country policies, domestic policy subsidies, government support, industrial chain integration, providing platform resources, providing information channels, online + offline, and intelligent logistics, to lay a preliminary foundation for the following axial coding. For ease of understanding, Table 3 lists the resulting categories and some original sentences. During the preparation of free nodes, there are 101 reference points in total.

4.2. Axial Coding. Axial coding refers to the secondary coding of existing coding data. At this stage, researchers are required to conduct an in-depth analysis of only one category at a time and look for relevant relations around this category. With the deepening of research, the relationship between various types becomes more and more specific and clear to find the "Axis." The particular method at this stage is to classify the categories of similar topics into one category and summarise the main types according to the relationship and logical order between different categories. The research theme of this paper is to explore the evolution mechanism of relevant subjects of ecosystem VcC of imported cross-border e-commerce platforms. After axial coding, it is found that there is organic correlation and logical order among 18 initial categories. For example, "industrial chain integration, online + offline" and "export country policy and government support" conform to the category of "resource integration and system support" in the platform and government behaviour in the process of VcC. According to the above theory, 18 initial categories formed by open coding are summarised at this stage. Finally, four main categories of "connection and interaction of value co-creators, resource integration, demand mining, system support" are formed. The concepts represented by each category are shown in Table 3:

4.3. Selective Coding. Selective coding refers to mining core categories from data, systematically analysing the categories obtained from axial coding, and supplementing the incomplete categories. The core category must be repeatedly proven to be dominant compared to other categories and include the most research results in a relatively broad theoretical scope. Through the reintegration of free nodes and tree nodes and the merger and reorganisation of axial codes, it is finally summarised into four core dimensions: connection and interaction of value co-creators, demand mining, resource integration, and system support. Then, it develops into a new substantive theoretical framework. To more intuitively understand the content covered by these structural dimensions, this paper uses NVivo 11.0 software has create a model of cross-border e-commerce platform ecosystem VcC dimension and content system, as shown in Figure 2.

5. Data Analysis

The research team analysed the results obtained from the coding, identified the critical node factors of the VcC realisation path of the imported cross-border e-commerce platform ecosystem, and then constructed a four-factor VcC model. They are "connection and interaction of value co-creators-resource integration-demand mining-system support." These four factors are highly condensed and covered in the VcC theory for stakeholders in the imported cross-border e-commerce platform ecosystem. It covers the theory of VcC realised by stakeholders under the ecosystem of imported cross-border e-commerce platforms. Among them, the connection and interaction of value co-creators constitute the causal conditions for the realisation of VcC. Resource integration constitutes the intermediary material condition for realising VcC. Demand mining is the action

Table 3: Example of a category formed by axial coding.

Main categories	Initial category	Original representative statement in the interview text
Connection and interaction of value co-creators	Cross-border e-commerce platforms and other platforms Cross-border e-commerce platforms and suppliers Cross-border e-commerce platforms and consumers Suppliers and consumers' suppliers	We always maintain a close relationship with suppliers, and the platform is actually doing very well in this regard. They did their best to serve their customers. The communication and exchange between suppliers on the cross-border e-commerce platform is very important, which is conducive to the development of enterprise thinking and help the platform create more values.
Resource integration	Industrial chain integration Providing platform resources Building information channels Online + offline Intelligent logistics	The growth of platform users has now entered a bottleneck period. If the platform wants to increase the number of users, it must formulate incentive policies to allow suppliers to carry out marketing flexibly on the platform. The platform is a distribution centre of information, including order information, payment information, settlement information, and logistics information of both buyers and sellers. When the above information is combined, many related businesses, such as finance and logistics, can be generated. These derivative industries will facilitate the expansion of the value chain of the platform.
Demand mining	Big data technology Questionnaire method Feedback supervision Postpurchase evaluation Social platform feedback	Social media segments should be added to cross-border e-commerce platforms. These sections can bring customers a better sense of experience, so as to increase the use of the platform. In hot or active communities, I would like to express my views and suggestions, which is similar to the super voice communication group of Micro-Blog. This form of social media can stimulate my desire to express.
System support	Export country policies Domestic policy subsidies Government support	Thanks to the government's effort, tariffs on many goods are gradually being reduced and even become zero tariff. China has always had strong support from the Chinese government. A case in point is the policy guidance for e-commerce under the background of RCEP.

strategy to realise VcC, and system support is the external environment support to realise VcC. Based on this, a new stakeholder VcC model under the import cross-border e-commerce platform ecosystem will be finally formed. The four factors in the model are described as follows.

5.1. Connection and Interaction of Value Co-Creators. The impact of the connection and interaction of value co-creators on the VcC mechanism of the ecosystem of imported cross-border e-commerce platforms is mainly reflected in five categories: cross-border e-commerce platforms and other platforms' cross-border e-commerce platforms and suppliers, cross-border e-commerce platforms and consumers, suppliers and consumers, and suppliers. The relationship between them is shown in Figure 3.

Under the cross-border e-commerce platform ecosystem, as a bridge connecting stakeholders in VcC, especially with the support of the Internet, the platform can analyse and apply massive data by using modern information technologies such as artificial intelligence, big data, and cloud computing. It is an information distribution centre for the interaction process of multiple stakeholders in VcC. The platform creates a collectively shared value ecosystem. Suppliers can adjust their business and integrate their relationships with consumers through the platform to realise the joint creation of value. The current Internet economy has a typical feature: users are king. The term "platform usage" often appears in the interviews and coding of the person in charge of the e-commerce platform and the supplier; for example, the person in charge of China JD.MALL global shopping division said: "users, platform users' growth is now a bottleneck period. It is necessary to open up the whole network users pool as soon as possible and let businesses do overall online marketing. What many businesses want to do, platform systems or rules, make it impossible for businesses to do." Therefore, the traditional cross-border e-commerce platform is just a place for shopping transactions, which is different from the platform that can realise content marketing, attracting users more quickly and sustainably.

In recent years, many social platforms focusing on content marketing in China are gradually expanding their business territory and stepping into the e-commerce industry. Take the Chinese largest social networking platform, TikTok and Weibo, as an example. The platform can market and promote products and services by increasing the function of living goods and opening window shops on the page of Internet celebrities. In the highly competitive cross-border e-commerce platform market, achieving long-term and stable users increase the key to the sustainable development of the platform. Traditional cross-border e-commerce platforms can cooperate with popular social media.

On the contrary, traditional platforms cannot guarantee the long-term stable growth of platform users, which is not

Figure 2: The structural dimensions and content system of value co-creation.

conducive to long-term maintenance of consumer stickiness, which will eventually lead to the dispersion of passenger flow. While the platform carries out third-party promotion activities, the "ecosystem + social" model of cross-border e-commerce platforms can be used by adding content marketing sections. The platform also needs to do the following to stimulate consumer purchase intention and maintain consumer stickiness: 1. continuously optimise the operation interface; 2. enhance the aesthetics of the page; and 3. continue to expand the information flow.

The traditional model cannot guarantee the long-term growth of the network user base, cannot maintain the user base for a long time, and eventually leads to the dispersion of passengers. Traditional cross-border e-commerce platforms are just platforms for commercial marketing, which are different from platforms where content marketing complements each other and attracts users quickly and sustainably.

In addition, cross-border e-commerce platforms can build different knowledge contribution platforms for popular imported products. For example, they built a luxury authenticity identification platform, health product recommendation platform, and infant scientific feeding platform. These services can fully mobilise consumers' enthusiasm for inclusive knowledge learning and ultimately realise knowledge co-creation. At the same time, the platform "Empowers" its suppliers. The platform's channels of "Empowering" can be summarised into three paths: accurate transaction matching, operation mode optimisation, and innovation-driven: first, we help suppliers efficiently match business opportunities and closely connect with many Chinese end consumers. Second, by providing intensive services such as payment, marketing, and logistics, we optimise the operation mode of suppliers, improve the ability of suppliers in network marketing and customer management, and bring more lasting competitive advantages to suppliers. Third, we drive supplier innovation with open strategy and shared resources to combine the shared resources provided by the platform according to their own needs and promote upgrading products and services. The "Empowerment" of the platform can improve the efficiency of suppliers and reduce their costs. Stimulate the vitality of suppliers' continuous innovation to a certain extent, enable suppliers to participate in the VcC process, and better create and deliver products and services worldwide. Empowerment of the platform has a positive role in promoting the VcC of suppliers and consumers under the platform ecosystem.

Under the cross-border e-commerce platform ecosystem, VcC is no longer limited to a simple binary interactive relationship but an ecological process in which multiple parties participate. Especially in the increasingly competitive market environment, cross-border e-commerce platforms

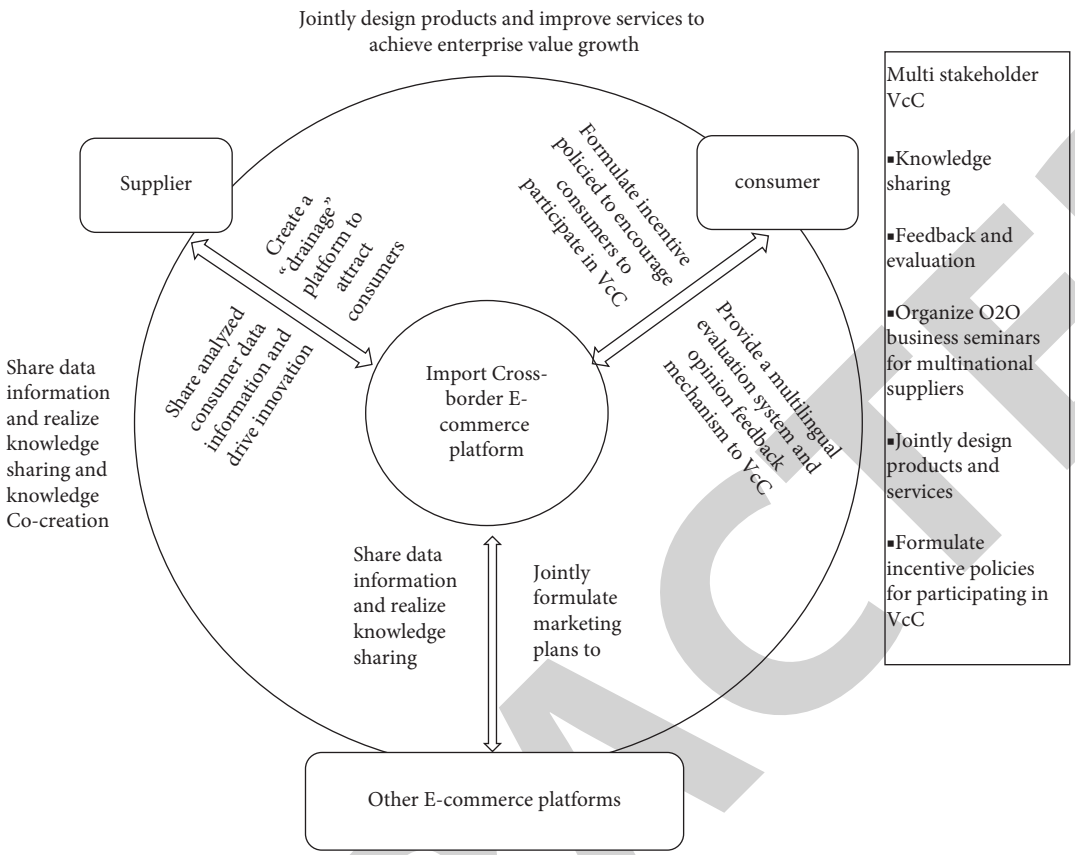

Figure 3: Connection and interaction of value co-creators of imported cross-border e-commerce platform.

cannot win only by "price advantage." The homogenisation of products and repeated business models prove that they cannot achieve long-term, stable, and good business performance only by themselves and even face the risk of being eliminated by the market at any time. In this case, the platform constantly drives the innovation of products and services to resist the cruel market. The cross-border e-commerce platform can take full advantage of its vital position in the ecosystem, unique information digital technology, and robust data resource integration ability to continuously promote the inflow of external rich knowledge resources into the platform to better dig and meet consumer needs continuously improve consumer satisfaction and loyalty. Finally, it will solve a series of difficulties such as poor operation sustainability and the short life cycle of cross-border e-commerce platforms. During the coding process, researchers found some purchasers have stated that "the communication between the suppliers on the platform is excellent, and this is conducive to the advantage of the platform" so that cross-border e-commerce platforms need to identify the needs of suppliers and intelligently classify and organise relevant information. In this way, cross-border e-commerce platforms can enter the process of VcC through the collaborative allocation of resources, such as sharing industry information with suppliers, supporting information exchanges between suppliers in the same industry, and holding industry sharing conferences. This process requires the platform to work with suppliers to make plans, jointly solve problems, and make flexible adjustments to promote more effective VcC. In general, the external driving force of cross-border e-commerce platforms for VcC is to meet personalised and diversified consumers. The internal driving force is the development motivation for innovation, efficiency, and winning in the industry. The internal and external driving forces together constitute the driving structure of their VcC activities.

Platforms continue to innovate products and services to combat raw markets. Cross-border e-commerce platforms can make full use of their excellent position in the ecosystem, unique information digitisation technologies and strong information resource integration capabilities, and can continuously promote the flow of rich external information resources on the platform for better use and satisfaction of needs. We increase customer satisfaction and loyalty.

Consumers realise a high degree of cooperation with suppliers through stable networks and communities on the cross-border e-commerce platform, which is not limited by time and region. The platform creates a collectively shared value ecosystem. This good environment stimulates consumers' willingness to participate in VcC in motivation and behaviour. Consumer participation in VcC is mainly concentrated in two stages: product design and product marketing. These two stages can be seen from respondents' representative views: "I have subscribed to the platform marketing number of my favourite brand. Because of the news push, I can see whether I like it or not and whether to

buy it. I have my ideas and hope that my favourite brand can solicit more opinions and opinions of old customers on new products, but there is no such way." It can be seen that they have personalised consumer demand and a strong willingness to create, can provide rich creative resources for suppliers, and stimulate consumers to contribute their demands and creativity, which is particularly important for the brand construction of suppliers. Enhancing consumers' brand preference through VcC has also become a hot issue in cross-border e-commerce.

Based on the above analysis, it is not difficult to see that the platform is a bridge for VcC between consumers and suppliers. The platform needs to continuously improve the quality of transaction products and mutual trust between stakeholders to improve the platform's value interaction function. The platform needs to meet consumers and suppliers' diverse and personalised communication needs. After the above conditions are met, the platform can achieve sustainable development through VcC. It can also allow stakeholders to share value to form a community of interests and promote VcC.

5.2. Resource Integration. The impact of resource integration on the ecosystem VcC mechanism of imported cross-border e-commerce platforms is mainly reflected in the five categories of industrial chain integration, providing platform resources, building information channels, online + offline, and intelligent logistics. With its pivotal position in the ecosystem, unique information digital technology, and strong resource integration ability, the Internet platform provides a resource guarantee for VcC. However, owning data resources is only the first step. However, owning data resources is only the first step. A more standardised integration of resources is required for imported cross-border e-commerce platforms to give full play to big data. During the coding process, both the charge person of the supplier and the consumer mentioned many times that they hoped the platform would make more efforts in data sharing and information communication. It can be seen that the platform is at the centre of the ecosystem and should play a good role. In recent years, the number of participants of cross-border e-commerce platforms has been increasing, and the scope has gradually expanded from large suppliers to small- and medium-sized suppliers. The platform has continuously improved its service functions and started integrating deep within and across industries.

The actual situation is that the entire cross-border e-commerce industry is still full of difficulties. First, although the quality of goods on the platform can be guaranteed, commodity transportation can reach consumers only through a series of international and domestic logistics procedures. Fake goods are easy to be mixed in the circulation process. At the same time, an effective commodity tracking system has not been fully established. That is, the "last mile" is represented by intelligent logistics, and the commodity return and exchange mechanism still need to be improved. Second, cross-border electronic payment faces institutional difficulties and technical risks. As the cross-border settlement is limited by credit and payment scope, the whole settlement process is very complex. Technically speaking, cross-border electronic payment is also threatened by security. Third, cross-border logistics needs to be further improved. Logistics plays a vital role in cross-border e-commerce. Logistics cost determines profitability, and logistics speed determines profitability. Especially for most small- and medium-sized suppliers, logistics is critical before the reality of low-profit rate. Cross-border e-commerce platforms face various problems and need to integrate services such as online payment, cross-border logistics, supply chain, customs clearance, and foreign exchange settlement to improve the overall service efficiency of the platform. The platform can provide merchants with more comprehensive supporting services by building a cross-border e-commerce ecosystem and genuinely realising the integration of the cross-border e-commerce industry chain.

(1) Although the quality of the goods on the platform can be guaranteed, the shipment of goods can only reach users through various international and domestic logistics procedures. Counterfeit materials are easily mixed during the circulation process.

(2) Cross-border electronic payments involve institutional difficulties and technical risks. Since international settlement is limited in terms of credit and payment amount, the whole settlement process is very complicated.

The massive data mastered by the cross-border e-commerce platform is an important strategic asset, so the platform should pay attention to data operation, data collection, and management. Only through these two stages can the value of data be fully reflected. Only by realising data-based operation and analysing consumers' purchase preferences through consumers' browse records and orders can the platform and suppliers' accurate marketing and accurate prediction be realised. For suppliers, only if the platform is willing to share the obtained data resources to mine adequate information from the data to study users' consumption habits, predict market trends, and continuously expand sales channels can they effectively reduce operating costs. At the same time, suppliers transform and innovate products and services through the information fed back by the platform, more accurately meet the needs of consumers, and obtain market opportunities and driving force for sustainable development.

Only by implementing data-driven transactions and analysing customer preferences through research and their order data can retailers and vendors achieve consistent sales and forecasting. For businesses, there is only one platform that is ready to share data resources, obtain sufficient information from data, analyse user usage patterns, predict market problems, and continuously improve sales channels, so that labour costs can be effectively reduced.

During the interview, the person in charge of the platform and supplier repeatedly stressed the importance of

using all data resources to achieve precision marketing. Therefore, it is necessary to achieve deep integration of online and offline. For example, actively carry out another new model O2O in the cross-border e-commerce industry, creating offline physical experience stores, and combining online shopping and offline experience with improving consumers' sense of user experience. The ultimate goal of the cross-border e-commerce platform ecosystem is to realise online and offline integration and enable platforms, suppliers, and consumers to participate in VcC through resource integration deeply.

5.3. Demand Mining. The impact of demand mining on the ecosystem VcC mechanism of imported cross-border e-commerce platforms is mainly reflected in five categories: big data technology, questionnaire method, feedback supervision, postpurchase evaluation, and social platform feedback. Big data is a new energy for the development of cross-border e-commerce. Cross-border e-commerce platforms focus more on collecting, mining, and applying big data. They can use big data technology to timely deliver data resources such as market changes and product demand information to suppliers. Furthermore, this will become the future competitive advantage of platforms and suppliers. Especially in the Internet age, if suppliers continue to follow the traditional closed innovation and rely on internal employees and self-reliance to create and develop innovation, it has been challenging to meet the times' needs.

The impact of demand mining on export e-commerce platforms to the domestic VcC system can be seen in five main areas: big data technology, research process, feedback management, postpurchase evaluation, and community feedback. Big data is a new force in cross-border marketing. Cross-border e-commerce platforms collect and use big data with great care. They can use big data technology to transmit data tools like market changes and information to sell products in time.

Moreover, mining consumer demand is also the process of consumers participating in VcC. VcC itself is to satisfy consumers better. For suppliers, products will directly face more personalised and diversified consumers. Therefore, it is urgent to dig into the needs of consumers deeply. In the process of consumers' participation in VcC, suppliers need to increase openness and release control so that customers can become active co-creators, creators, and decision-makers.

Feedback, supervision, and after-sales evaluation are the main ways for cross-border e-commerce platforms to create value with consumers. They are also essential links for direct interaction between the platform and consumers and demand mining. The platform can directly use background orders to generate data such as commodity repurchase rate and industry benefits to achieve preliminary mining of consumer demand. However, at present, the communication links of many cross-border e-commerce platforms have not been fully opened up. For example, the platform can respond to consumers' questions at any time by adding the number of customer service specialists so as not to keep consumers waiting. At the same time, a complete set of scientific feedback mechanisms should be improved. In this link, the feedback module function should be added, and the operation specialist should be arranged to sort out and analyse consumer opinions, suggestions, and other information. As mentioned above, the new "e-commerce + social networking" model is also a meaningful way to dig consumer demand for platforms and suppliers. We must understand that consumers are not just recipients of unilateral value but want to create value with suppliers. What consumers want is "interaction," not "indoctrination." Therefore, platforms and suppliers should cooperate extensively to build a social e-commerce ecosystem. The platform can use virtual community forums to allow consumers to participate in product design and product marketing to stimulate their needs and desires. The platform can also use data analysis technology to mine hotly discussed products in the comment area, allowing consumers to participate in product innovation. These activities can meet the individual needs of consumers, cultivate customer groups, and help suppliers make strategic decisions. Statistics from relevant research institutions show that Chinese social e-commerce has 170 million monthly active users, effectively meeting consumers' multilevel and diversified needs.

Demand mining process under the ecosystem of import cross-border e-commerce platform is shown in Figure 4.

5.4. System Support. The impact of system support on the ecosystem VcC mechanism of imported cross-border e-commerce platforms is mainly reflected in three categories: export country policies, domestic policy subsidies, and government support. Cross-border e-commerce has brought new development opportunities to more countries and groups and is essential for building an open world economy. In the early stage of Chinese cross-border e-commerce development, the government adopted an attitude of affirming and encouraging the development of new things. The rapid rise of the cross-border e-commerce industry primarily benefits from the improvement and standardisation of the policy environment. The suppliers discussed in this paper come from different countries, so the tolerance and support of exporting countries for the cross-border e-commerce industry is significant. Facing many problems and development bottlenecks in the cross-border e-commerce industry, the Matthew effect of the e-commerce platform is noticeable. The original regulatory system and import and export process have become the main factors restricting the development. In addition, the credit problems of cross-border payments and the infringement of various types of brands are still occurring. These two issues need to be resolved by the Chinese government through continuous improvement of relevant industry rules, laws, and regulations. These measures will play a positive role in the VcC of the cross-border e-commerce platform ecosystem. Of course, the Chinese government is also making continuous efforts, such as selecting some cities as pilots to explore the management systems and rules for developing cross-border e-commerce. At the same time, the government

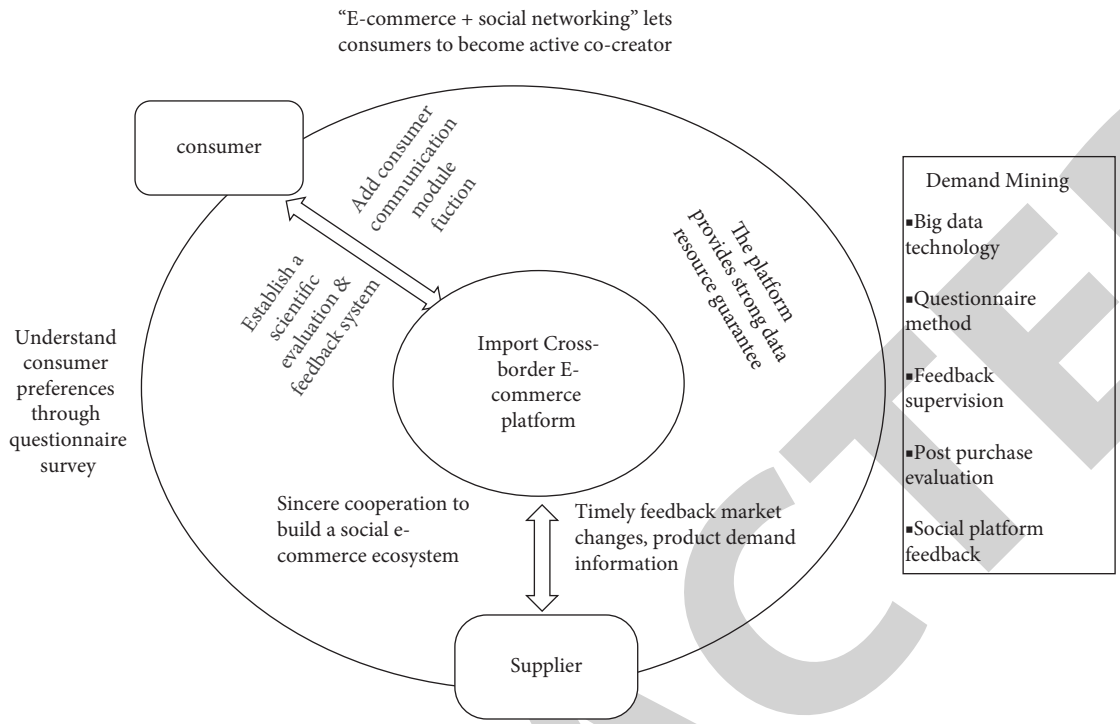

Figure 4: Demand mining process under the ecosystem of import cross-border e-commerce platform.

comprehensively promoted the "six systems" of regulatory services such as cross-border e-commerce information sharing, financial services, intelligent logistics, and risk prevention and control, and mature management experience such as "two platforms" of comprehensive online services and comprehensive offline areas, to drive cross-border e-commerce into the rapid development.

The healthy development of any industry is inseparable from good industry rules. The governments of many supplier countries have successively issued institutional guidelines to regulate the cross-border e-commerce industry and issued several policies such as industrial subsidies and product tariff subsidies to support cross-border e-commerce exports. However, due to the rapid rise of cross-border e-commerce platforms and the emergence of new operation modes and promotion modes, the original industry rules cannot keep up with the current changes. Given various problems existing in the industry, governments should constantly improve the existing regulatory system. The policy support of governments to the cross-border e-commerce industry is also an essential basis for effective VcC in continuously and improving the industry development environment of cross-border e-commerce. The government's strong support is significant for the VcC of cross-border e-commerce platform ecosystem stakeholders. In the future, the government should increase support for cross-border e-commerce.

6. Conclusion

This paper uses grounded theoretical analysis methods to conduct an exploratory study on the mechanism and path of VcC of stakeholders in the imported cross-border e-commerce platform ecosystem. This article finally summarises four significant factors: connection and interaction of value co-creators, resource integration, demand mining, and system support. It summarises and extracts four factors: the connection and interaction of value co-creators, resource integration, demand mining, and institutional support. The theoretical contribution of this paper is reflected in three aspects: (1) the previous research related to cross-border e-commerce platforms mainly focused on a platform concept, platform construction mode, platform competition, platform business model, and others. There is no research to connect cross-border e-commerce with the platform ecosystem, which is a valuable supplement to the existing theory of the platform ecosystem; (2) due to the large number of stakeholders involved in the imported cross-border e-commerce platform, the binary interactive subjects in the existing research are expanded. The research involving more subjects also means that the research is more complex, which is a further in-depth exploration of the research on VcC. (3) The existing research primarily focuses on the connotation and influencing factors of VcC. This paper selects the grounded theory method to study the VcC mechanism of stakeholders under the ecosystem of imported cross-border e-commerce platforms, combs the main paths of VcC among platform, suppliers, and consumers, and can provide a theoretical basis for the follow-up study of the stakeholder VcC mechanism.

This paper focuses on cross-border e-commerce platforms and suppliers to make better use of the platform ecosystem. The realisation of sustainable development has brought the following two management enlightenment: (1)

by discussing the VcC mechanism and path of the ecosystem of imported cross-border e-commerce platforms. The four dimensions can help the cross-border e-commerce platform and supplier management understand VcC more deeply and play a guiding role in specific business operations in practice combined with relevant theories. (2) In order to successfully realise the transformation from VcC to enterprise performance, suppliers should strive to establish a suitable trust mechanism with the platform, form a community of interests, and uniformly promote effective implementation methods of VcC. The two sides can improve enterprise performance through the following three VcC activities: A. formulate plans to optimise strategic decisions; B. solve problems together to improve work efficiency; C. establish a communication and negotiation mechanism to increase market shares. (3) Encourage consumers to create value and cultivate brand preference. This preference can strongly stimulate consumers' purchases and promote continuous purchases, which is very important for the sustainable development of suppliers' brands.

In the future, the research team plans further to expand its research results in the following three directions: (1) add two representative cross-border e-commerce platform enterprises in China as samples and add crawler technology to the original data collection method to obtain more enterprise information and consumer behaviour data. (2) Logistics parties and financial institutions are added to the original stakeholders of VcC, and the theory of ecosystem VcC mechanism of imported cross-border e-commerce platforms is further combed through the expansion of extensive sample data and research scope. (3) Join quantitative research methods such as regression analysis and empirical research methods to verify the impact mechanism of external and internal factors on the VcC efficiency of multiparticipants.

Data Availability

The experimental data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

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

Authors' Contributions

C.P. conceptualised the data, wrote, and edited; X.J. conceptualised, formally analysed the data, performed coding of software, and validated the data; J.T. reviewed and edited the study; P.C. conceptualised the data, and reviewed and edited the study. All authors have read and agreed to the published version of the manuscript.

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Retraction

Retracted: Analysis of English Education Quality Evaluation and Internationalization Integration Based on Deep Learning

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Song and G. Yang, "Analysis of English Education Quality Evaluation and Internationalization Integration Based on Deep Learning," *Security and Communication Networks*, vol. 2022, Article ID 9436538, 9 pages, 2022.

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Research Article

Analysis of English Education Quality Evaluation and Internationalization Integration Based on Deep Learning

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English education is one of the most active research directions in the field of natural language processing. With the gradual implementation of deep learning in various fields, more and more industries have begun to use deep learning to carry out more efficient work. In the field of education, it is also urgent to adopt a more intelligent set of algorithms to relieve the pressure of teachers to correct test papers, and also to increase the fairness of non-subjective evaluations in the process of scoring. Teachers conduct teaching evaluation when the concept of teaching evaluation is not clear; there are defects in learning evaluation goals; there are many problems in the relationship between ability evaluation and knowledge evaluation; in the process of English teaching evaluation, the phenomenon of using summative evaluation instead of procedural evaluation is very serious. Therefore, this subject uses deep learning to study the problem of text line positioning and recognition. At the same time, this subject also builds a text scoring network based on RNN and STLM as a quantitative evaluation index for text line detection and recognition algorithms. We will examine students later. Whether problem-based learning theory can be used to promote deep learning among students to determine whether students' systematic use of PBL in teaching can promote the use of deep learning in college English courses. Finally, comparing the effects of deep learning and shallow learning, it is concluded that the evaluation of deep English teaching can provide students with more learning opportunities, access to more learning-related materials, and questions are more transparent and are free, which is easy. It is speculated that the purpose of this problem is to facilitate the use of deep learning methods to find meaning types.

1. Introduction

We find that even Chinese provinces still rely more on goods from the rest of China than on international imports, implying greater discontinuity in the Chinese domestic market [1]. Traditional economic integration theories are notable for their failure to view the integration process itself as capitalism. In most cases, this theory implicitly assumes a framework of harmonious relations between capital and labor, thereby abstracting class relations in integration [2]. After decades of ups and downs in foreign language education in China, English regained its dominant position after 1949. In order to meet the challenges of the new century, we must fully understand the importance of foreign language design and pay attention to the problems in English teaching [3]. English is widely spoken around the world as an international language. In universities, bilingual teaching should be gradually introduced, focusing on students' communicative ability, focusing on speaking and writing, and network-based computer technology provides learners with an environment where they can actually communicate in English [4]. This article provides an overview of deep learning in neural networks, including popular architectural models and training algorithms. Deep learning is the part of machine learning that attempts to model high-level knowledge abstractions using multiple layers of neurons consisting of complex structures or nonlinear transformations [5]. Deep learning is capable of learning computer

models composed of multiple layers of processing from data representations at multiple levels of abstraction. These methods include visual object recognition, object and domain recognition [6]. Through extensive systematic experiments in this paper, we show how these traditional methods fail to explain why large neural networks generalize well in practice, and we confirm these experimental results with a theoretical structure that shows that as long as the number of parameters exceeds the data, the number of points, simple deep binary neural networks already have completely limited sample representation properties [7]. Factors associated with disadvantage expand as children enter the workforce through the education system. We document various forms of inequality in education, and we then review the available evidence in England on the impact of school-level policies on achievement and their potential to reduce the socioeconomic disparities [8]. This paper considers how English as a foreign language (EFL) can be taught more effectively in China by incorporating lessons from twentieth century English learning experiences. The main purpose is to learn more about how English was taught at different times. This information can be identified by identifying curriculum construction, successful and unsuccessful practices in teaching methods, and teaching materials to inform current and future practice [9]. Learning a language is very important in our globalized world, and this study aimed to investigate parental attitudes towards English education for kindergarten students, in which questionnaires were used as a data collection tool [10]. Extensive reading is a learning method that improves a learner's reading comprehension by reading many light-hearted books. We read extensively as part of the English education program at Shinshu University. In this study, we developed and operated an online extensive reading support system, and the results reveal how students feel about their progress and how to reduce the burden of extensive reading while staying motivated [11]. We conducted TOEIC-IP twice in three types of courses (1) general English + self-study listening CD-ROM, (2) WEB English learning system called Gyutoe, and (3) control class, the result was WEB learning system compared with the other two systems, it brings a significant score improvement. This result demonstrates the benefits of a WEB-based English learning system [12]. English education is often still seen as a purely instrumental effort. This article illustrates how English plays a role in an education system in a developing country that is rapidly becoming a rich base for alternative education research. This paper places English within the pragmatics of postcolonial mentality and the sociocultural expectations of stakeholders, and addresses the complexities of transitioning from policy to practice [13]. Improving vocational learning in general and vocational education and training programmes and qualifications has never been more important on the political agenda. This bias is dissected in the context of the most popular strategies for enhancing vocational learning and equal respect for programmes and qualifications in this field. It was concluded that changing terminology and modifying paths would not bring about the necessary shift in values needed to achieve the desired goals [14]. One of the underexplored areas of research in the language learning literature is investigating the role of various contextual factors influencing second/foreign language motivation. As foreign language teaching in Iran is relatively unique in terms of teaching and learning environments, this study examines the combined effects of these situational characteristics on changes in students' motivation after four years of English learning in high school. The study concluded that these changes in student motivation are due to the influence of traditional teaching environments and conservative policies for foreign language teaching. Clearly, in the context of this kind of English teaching, improving the motivation of learners requires scientific reforms within the education system [15].

2. Research Overview of Deep Learning

2.1. Overview of Foreign Deep Learning Research. Marto and Sajlo of the University of Gothenburg in Sweden first proposed slowing down "deep learning" study abroad. In 1976, he dealt with data processing in learning methods, and the ability to interpret shallow and layer-by-layer changes. When a student uses superficial learning methods, his or her response is only at a low level, and the learning process also seems to be mechanical memory learning. He excels at subject and text topics when he uses deep learning methods. Therefore, the two researchers introduced the concept of "deep learning," arguing that immersion is a process of knowledge transfer that can help learners improve their ability to improve problems and become scientifically minded.

2.2. Overview of Domestic Deep Learning Research. Deep learning plays an important and constructive role in promoting students' information processing, in-depth analysis, innovation, and development. If students gradually get rid of the superficial learning state, and achieve the state of understanding and applying words through simple word repetition and expansion, the learning effect will be improved. If teachers can wisely combine deep learning theory and design English vocabulary lesson plans suitable for students' learning, vocabulary teaching will also have good learning effects. Under the guidance of deep learning theory, students can lay a good vocabulary foundation and gradually implement in-depth learning of English vocabulary. At the same time, teaching under the guidance of deep learning theory can improve students' thinking level and increase their enthusiasm for learning English. At the same time, it can improve students' autonomous learning ability, problem-solving ability, transfer application ability, and knowledge innovation ability.

2.3. Overview of English Vocabulary Teaching Research. Vocabulary teaching methods have also changed. Starting from the vocabulary teaching methods, the context of vocabulary and the emphasis on thinking training in vocabulary teaching have changed, and the vocabulary teaching methods have also changed. It can be seen that in recent years, the vocabulary teaching mode has gradually

improved, and became more scientific and in-depth. On this basis, the vocabulary teaching guided by the deep learning theory is also in line with the new method of education supported by the education community, lifelong learning, critical thinking and advanced thinking training, and student-centered education. This paper integrates deep learning into high school English vocabulary teaching. Combining deep learning theory with vocabulary construction strategies can help teachers think about vocabulary teaching and bring new ideas for the development of English vocabulary teaching. Provides more comprehensive strategies for teachers who learn English vocabulary and teach English vocabulary. Vocabulary teaching guided by the construction of deep learning theory will conform to the development and trend of the times and is expected to become a reference for vocabulary teaching in the new era.

2.4. The Theoretical Basis of English Teaching. According to the definition of deep learning and most of the learning process, it can be clearly seen that teaching under the guidance of deep learning theory requires the active construction of students and the careful guidance of teachers. Teachers should use previously learned knowledge when teaching vocabulary information. Students do not master vocabulary until they learn vocabulary for a new unit. They already have a certain vocabulary and life experience to learn English vocabulary every day. NaMA knowledge and experience can support or prevent the learning of new words. Therefore, when teaching English words, in addition to normal guidance, teachers should also be fully involved in the information or experience that hinders the words, allowing students to learn meaningfully and helping students learn from ancient knowledge and experience. Based on current experience, help students to think deeply through meaning construction, change their knowledge, experience and values, promote students' ability to form words in speech, and promote effective and deep learning.

3. Text Recognition Algorithms Based on Deep Learning

3.1. Recurrent Neural Network RNN. RNN (recurrent neural network) is mainly used to deal with timing problems. There is a connection between each neuron state in the hidden layer of RNN. The input in the neuron state not only includes the input of the input layer, but also includes the output of the previous neuron state. The semantic information before and after the text sequence is very important for the recognition accuracy of the current sequence, so RNNs are mostly used in text recognition, speech recognition and other tasks.

3.2. Long Short-Term Memory Network LSTM. The difference between LSTM and ordinary recurrent neural network is that it has three gating units to retain the information of the previous neuron, thereby reducing the loss of information in the transmission of neurons. At the same time, LSTM can also solve the problem of gradient descent. The "gate" structure in LSTM allows it to selectively retain or discard information, and the gate structure is the sigmoid function multiplied point by point. The output of the sigmoid function is between 0 and 1. This output value represents the amount of information retained, that is, when the value is 1, all information flows to the next network structure; when the value is 0, the gate structure is closed, and all information does not pass through the gate control unit. LSTM determines the information discarded in the network through the "forgetting gate," and the decision rule is determined by the current input and the state of the previous hidden layer h_{t-1}. The "forget gate" is essentially a sigmoid function layer, which is used to forget the useless prediction information that may lead to errors. The expression of "forgetting gate" defined by LSTM is as formula (1): where x_t is the input at the current moment, h_{t-1} is the state of the previous hidden layer, and the judgment result f is also a vector with a dimension of n ranging from 0 to 1. Because any dimension in the f vector has a range of values between 0 and 1, dimensions with values close to 0 will be discarded by the forget gate, and dimensions with values close to 1 will be retained.

$$f_t = sigmoid\left(W\left[h_{t-1}, x_t\right] + b_f\right). \tag{1}$$

LSTM will discard the wrong information after passing the "forgetting gate," and the current valid input information needs to be stored in the neuron state to supplement the new information of the network, so the function of the "input gate" is to store the new valid information in the LSTM. The "input gate" mainly consists of two parts. First, the tanh function layer generates a vector that can be stored in the neural network, and then, the sigmoid function layer outputs a value ranging from 0 to 1. The "input gate" expressions defined by LSTM are such as equations (2) and (3): where x, is the input at the current moment, and h_{t-1} is the state of the previous hidden layer. If the LSTM needs to update the current information, the information to be stored is combined with the previous neuron state Cq-: through the update gate to generate a new neuron state Gq. Update state expressions such as (4)

$$z_t = \tanh\left(W_z\left[h_{t-1}, x_t\right] + b_z\right., \tag{2}$$

$$i_t = sigmoid\left(W_i\left[h_{t-1}, x_t\right] + b_i\right), \tag{3}$$

$$c_t = f_t * c_{t-1} + i_t * z_i. \tag{4}$$

Tanh is one of the hyperbolic functions, which is widely used as the activation function of neurons in neural networks in the field of deep learning. Finally, the "output gate" determines the output h_t, h_t of the LSTM. It is jointly determined by the updated neuron state c, the output h_t of the previous hidden layer, and the input x_t of the current neuron. First, the sigmoid function layer determines the neuron state o_t to be output, and then sends the updated neuron state c to the tan$h$ function layer, and multiplies the

output result of the sigmoid function layer, so that the LSTM only outputs the part that needs to be output. The expression of "output gate" defined by LSTM is as formulas (5) and (6):

$$o_t = sigmoid\left(W_o\left[h_{t-1}, x_t\right] + b_o,\right. \tag{5}$$

$$h_t = o_t{}^* \tanh\left(c_t\right). \tag{6}$$

The sigmoid function is a common function in biology, also known as the growth curve. In information science, the function is often used as the activation function of neural networks to map variables between 0 and 1.

3.3. Text Line Detection Model Based on CTPN. The y-axis coordinate of the returned text area height vh is shown in formula (7), and the y-axis coordinate of the center Vc of the bounding box is shown in formula (8). The representation of $*$ is GroundTruth, and the representation is the anchor point. Finally, multiple dense fine-grained candidate boxes are merged into text lines through a text line construction algorithm.

$$\begin{aligned} v_h &= \log\left(\frac{h}{h^a}\right), \\ v^*{}_h &= \log\left(\frac{h^*}{h^a}\right), \end{aligned} \tag{7}$$

$$\begin{aligned} v_c &\frac{\left(c_y - c_y^a\right)}{h^a}, \\ v_c^* &\frac{\left(c_y^* - c_y^a\right)}{h^a}. \end{aligned} \tag{8}$$

3.4. Improved MLC-CRNN Feature Extraction Layer Based on Multi-Feature Fusion. In the handwriting recognition task of this topic, the letters written by students can be regarded as small objects, and multi-feature fusion can prevent the recognition accuracy of small objects from decreasing. The idea of feature extraction of multi-feature fusion module is shown in equations (9)–(11). The convolutional layer with multiple feature extraction units fuses features of different depths to improve the ability to describe the features of the image itself. By fusing a smaller convolutional layer and a larger convolutional layer on two branches, both low-level features (such as letters) and high-level features (such as words) of the handwritten text can be learned well. This subject named this multi-feature fusion module as MLC module (Multi-LayerConvolutionsBlock).

$$\begin{aligned} y_n^1 &= W_n^1 \cdot h_{n-1} + b_n^1, \\ y_n^2 &= W_n^2 \cdot h_{n-1} + b_n^2, \\ y_n^3 &= W_n^3 \cdot h_{n-1} + b_n^3, \end{aligned} \tag{9}$$

$$h_n = sigmoid\left(y_n^1 + y_n^1 + y_n^1\right), \tag{10}$$

$$\begin{aligned} y_{n+1} &= W_{n+1} \cdot \left(h_n + bn + 1\right) \\ &= W_{n+1} \cdot \tanh y_n + b_{n+1}. \end{aligned} \tag{11}$$

3.5. CRNN Feature Sequence Prediction Layer Based on Bi-directional LSTM. Therefore, this topic adopts Bi-LSTM to learn the sequence features of in-line context of a long text. The experiments combine a forward pass and a backward pass LSTM into a bidirectional LSTM (Bi-LSTM), which generates a deep Bi-LSTM by stacking multiple Bi-LSTMs. Among them, for the forward pass, when the input feature sequence $x = x_{1,}x_{2,} \ldots x_{t,}$ is passed into the forward LSTM, a set of neuron states $u = u_1, u_2, \ldots u_t$ will be obtained, as shown in equation (12); for the backward pass, the input sequence of the feature sequence is the same as $x = x_{1,}x_{2,} \ldots x_t$, which is passed into the backward LSTM, and another group of neuron states $z = z_1, z_2, \ldots z_t$ will be obtained, as shown in equation (13). Finally, through the SoftMax function operation, the column vector $y = y_1, y_2, \ldots y_t$ output by the sequence prediction unit represents the prediction probability of the corresponding text, as shown in formula (14).

$$u_t = Wh_t + b, \tag{12}$$

$$z_t = W' h_t + b', \tag{13}$$

$$\begin{aligned} y_{ut} &= \frac{e^{u_i^t}}{\sum_{k=1}^k e^{u_t^k}}, \\ y_{zt} &= \frac{e^{z_i^t}}{\sum_{k=1}^k e^{z_t^k}}. \end{aligned} \tag{14}$$

LSTM mode is a type of RNN, consisting of forward LSTM and backward LSTM, which are commonly used to model contextual information in natural language processing tasks. Using LSTM models can better capture long-range dependencies, while Bi-LSTM can better capture bi-directional semantics.

3.6. CRNN Sequence Transcription Layer Based on CYC Mechanism. CTC introduced a blank insertion mechanism, which uses the "_" symbol to represent blank labels. That is, the label "aaaaattt" is mapped to "aab" under the CTC mechanism, and "aaaaattt" is mapped to "at." But at the same time, time series composed of multiple different characters such as "aa-aaaattt" and "aa-aaaaatt" will be mapped to the same output word "aat" at the same time | that is, there is one or more mapping paths for the same label. For example, in the experiment of this subject, the high-frequency word "write" that appears in the English composition of primary and secondary schools has many different paths, such as equations (15) to (18), and the mapping result is "write":

$$B\left(\pi_1\right) = B\left(wwr - ii - t - - - e\right) = \text{"write"}, \tag{15}$$

$$B\left(\pi_2\right) = B\left(- - \text{wrri} - t - - - e\right) = \text{"write"}, \tag{16}$$

$$B(\pi_3) = B(wwr - \text{iii} - \text{tee}-) = \text{“write”}, \tag{17}$$

$$B(\pi_4) = B(- - \text{wrrii} - \text{tee}-) = \text{“write”}, \tag{18}$$

Since the last RNN output is the probability matrix of the sequence, then, for $B(\pi 1)$, the mapping probability is shown in equations:

$$p(\pi = (wwr - ii - t - -e)|x, S) = \sum_t y_{\pi t}^t, \tag{19}$$

$$\sum_t y_{\pi t}^t = \left(y_w^1\right) \times \left(y_w^2\right) \times \left(y_w^3\right) \times \left(y_r^4\right) \times \left(y_w^5\right) \times \left(y_-^6\right) \times \left(y_t^7\right) \times \left(y_i^8\right) \times \left(y_w^9\right) \times \left(y_-^{10}\right) \times \left(y_e^{11}\right) \times \left(y_w^{12}\right). \tag{20}$$

Input a text image into the network, the input space is a set X composed of text sequences $x = x_1, x_2, \ldots x_t$, the input text sequence, the result space is a set L composed of output label sequences, T is the length, B is the text sequence to label sequence mapping function. The experiment should maximize the probability that the output is the result space L. Since the mapping paths are mutually exclusive, the sum of all probabilities mapped to L based on the mapping function X is the conditional probability equation:

$$p(l \mid x) = \sum_{\pi \in B^{-1}(l)} p(\pi \mid x). \tag{21}$$

CTC trains and decodes all labels, performs many-to-one alignment output, sums all paths, and calculates the maximum value of the above conditional probability formula (21). The output of the final time series classifier equation (22) is the most likely sequence label of the input text sequence.

$$h(x) = \text{argmax} p(l \mid x). \tag{22}$$

3.7. Experimental Details and Verification Effects. In order to prove the effectiveness of the scoring network, this subject conducts experiments on CNN + LSTM network and CNN alone with LSTM using 12948 passages in the dataset. The experiment uses the RMSProp optimizer to minimize the mean square error (MSE). The loss function of MSE is shown in equation (23), where s represents the text prediction score s_i represents the gold-score of the text label:

$$MSE(s, s^*) = \frac{1}{N} \sum_{i=1}^{N} \left(s_i - s_t^*\right)^2. \tag{23}$$

The experiment uses the averaged quadratic weighted Kappa coefficient (average QWK coefficient) as the evaluation index to measure the performance of the scoring module. The calculation formula of the average QWK coefficient is as equations (24) and (25), which represents the agreement between the predicted value (i) and the true value label (j)

$$k = 1 - \frac{\sum_i \text{jwi, joi, } j}{\sum_i \text{jwi, jEi, } j}, \tag{24}$$

where, w_i represents the quantified score of the difference between the predicted value and the true value

$$w_{i,j} = \frac{(i - j)^2}{(N - 1)^2}. \tag{25}$$

4. Research Findings and Discussion

4.1. Experimental Data Collection. The questionnaires of the two classes were collected and uploaded through the Questionnaire Star platform, and the test scores were obtained from the blackboard. In the pre-pilot stage, 33 students completed the two questionnaires before and after, we received 33 valid questionnaire responses. Students in both classes passed the exam, which consisted of an English proficiency test, an objective test based on textual content, and an essay. The questionnaire data and test data were analyzed by EXCEL and SPSS22, and the interview data were mainly analyzed and compressed by three-level coding. It describes the results of a survey of 33 students in the whole class before problem-oriented learning, and 33 valid questionnaires. Among them, the lowest score of the deep learning subscale of this survey was 15, the maximum value was 42, and the theoretical score of this subscale was 10–50. It can be seen that the students in this class vary greatly in the use of deep learning methods among individuals, and the use of shallow learning methods is the same. Furthermore, deep learning scores were higher than superficial learning, so it is prudent to conclude that students are more likely to use deep learning methods in English classes. 4.2 statistics and analysis of questionnaire results. Table 1 describes the data of the problem-oriented learning course. The results are that a questionnaire survey was conducted on 33 students in the whole class before the start of the course, and 33 valid questionnaire responses were obtained. Among them, the deep learning subscale of the questionnaire has a minimum score of 15 points and a maximum score of 42 points. The theoretical score range of this subscale was 10 to 50 points. Obviously, the use of deep learning methods by students in this class varies from strong to individual, and the use of superficial learning methods is the same. In addition, the scoring metrics for deep learning were higher than those for surface learning. It can be concluded that students were more inclined to use deep learning methods in natural English courses.

4.2. Statistics and Analysis of Questionnaire Results. Table 1 describes the data of the problem-oriented learning course. The results are that a questionnaire survey was conducted on 33 students in the whole class before the start of the course, and 33 valid questionnaire responses were obtained. Among them, the deep learning subscale of the questionnaire had a minimum score of 15 points and a maximum score of 42 points. The theoretical score range of this subscale was 10 to 50 points. Obviously, the use of deep

Table 1: Questionnaire results of students' learning methods before the course starts.

Category	N	Minimum	Maximum value	Average	Standard deviation
Deep learning (DA1)	32	16	46	32.35	8.13
Shallow learning (SA1)	32	14	36	28.36	7.35
Effective N (listwise)	32	12	43	25.55	31.33

learning methods by students in this class varies from strong to individual, and the use of superficial learning methods was the same. In addition, the scoring metrics for deep learning were higher than those for surface learning. It can be concluded that students were more inclined to use deep learning methods in natural English courses.

Table 2 from the average scores of deep learning and superficial learning, it can be seen that to a certain extent, students were more inclined to use deep learning methods after completing the course, while there were superficial learning methods in the course.

As shown in Table 2, a paired sample t-test was performed on the scores of the deep learning subscales before and after the tested students. ($T = -1.941$, $df = 32$, $p = 0.061 > 0.05$). $T(30)$ in Figure 1 indicates that the number of samples is 30, and MD indicates the information data of students' shallow learning. A paired sample t-test was performed on the scores of the tested students before and after the superficial learning subscale. The results are shown in Figure 1. The scores for the second subscale of shallow learning were not significantly different from those for the first ($T = 1.894$, $df = 32$, $p = 0.067 > 0.05$).

As shown in the survey, there were two parameter tables for shallow learning, and the collected data were descriptively analyzed, as shown in Table 3. Show:

Since the difference between the lowest and the highest scores of undergraduates was 32, and the standard deviation SD1 = 5,734, it can be observed that the density of students who choose the undergraduate method before taking the English intensive program varies widely; the frequency of choosing the low study method also varies widely big. In addition, according to the scores of the two subscales (10–50), the average score of the students' deep learning scale is 33.40, which is greater than 3, while the average score of the shallow learning scale is 26, 78, which is less than 30 people. So far, it can be concluded that a group of students is before the start of the course. You may want to use deep learning methods in your English classes. After the course, the same questionnaires were distributed to the tested students again, and a total of 53 valid questionnaires were collected for descriptive analysis, as shown in Figure 2. Standard deviation is a statistical term. The smaller the standard deviation, the less the value deviates from the mean, and vice versa. The size of the standard deviation can be measured by the ratio of the standard deviation to the mean.

The data results in Figure 2 show that the maximum value of deep learning was higher than that of shallow learning, the fluctuation of deep learning was larger, and the variation of shallow learning was small. Through the comparison of Table 3 and Figure 2, it is worth noting that it is not possible to infer from the descriptive material whether there is a significant difference in the use of deep learning and shallow learning by students before and after the course, so further analysis is required. The list of students with valid data from the first and the second surveys screened a total of 47 students who participated in the two surveys, and performed a paired t-test on the data from the deep learning and surface learning scales, and the results are shown in Figure 3.

Through the data in Figures 3 and 4, the differences between the two samples before and after deep learning and shallow learning can be compared, as shown in Figure 5.

$T(30)$ represents the number of samples 30, and MD represents the information data of deep learning and shallow learning. The graph above shows that the scores on the two deep scales were not significantly different from those on the two low scales in subjects before and after the course (sample $T = -1.091$, $df = 46$, $p = 0.281 > 0.05$). The scores were also not significantly different ($T = -1.934$, $df = 46$, $p = 0.059 > 0.05$). df stands for degrees of freedom and is the number of variables with infinite values when computing a statistic. p value is a parameter used to determine the outcome of a hypothesis test. The smaller the p value, the more significant the result. As can be seen, based on the results of the dual L-learning process survey, it cannot be concluded that the PBL curriculum developed in the study will have a significant impact on student learning and the use of superficial learning methods. However, since the survey data is one or two online surveys filled out using the Questionnaire Star platform, some students repeatedly completed and submitted the survey, and the researchers first adopted the data, these situations may cause the survey data to not reflect the overall situation, so in the research on student learning, it is necessary to combine student performance analysis and homework to continuously draw student learning conclusions that are closer to the real situation.

4.3. Analysis and Evaluation of PBL. English homework results there are also independent studies before and after PBL courses. In the past, the main goal of self-study was to complete learning tasks to obtain better grades. People tend to choose a "conservative action plan," that is, to try to achieve the learning goals set by teachers as little as possible. Possibly, in PBL learning, self-learning goals are influenced by personal interests and peer inspiration. In addition to achieving good grades, they also focus on individualized and comprehensive learning, and their learning input and learning effect have greatly improved. Of course, some people have reservations about cooperative learning. They found that cooperative learning was time-consuming and labor-intensive, preventing them from orienting their studies and completing tasks. This may be related to

Table 2: Results of the student learning methods questionnaire after the start of the course.

Category	*N*	Minimum	Maximum value	Average	Standard deviation
Deep learning (DA1)	34	17	47	36.5	8.35
Shallow learning (SA1)	34	13	35	275	7.65
Effective *N* (listwise)	34	13	42	26.7	32.67

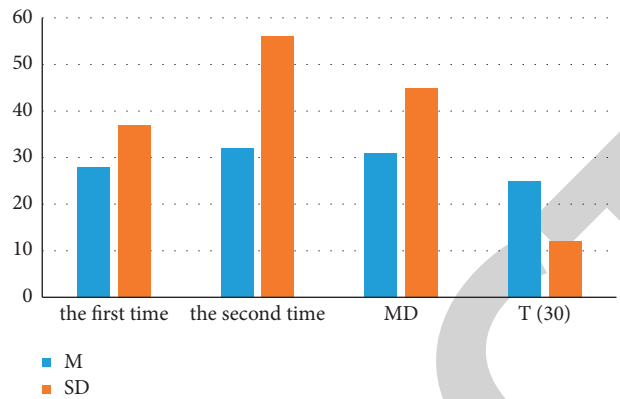

Figure 1: Differences in the subscale scores of the two shallow learning subscales.

Table 3: Descriptive statistics of the first test results.

Category	*N*	Minimum	Maximum value	Average	Standard deviation
Deep learning (DA1)	56	21	65	56	36
Shallow learning (SA1)	56	16	38	36	28
Effective *N* (listwise)	56	18	52	45	48

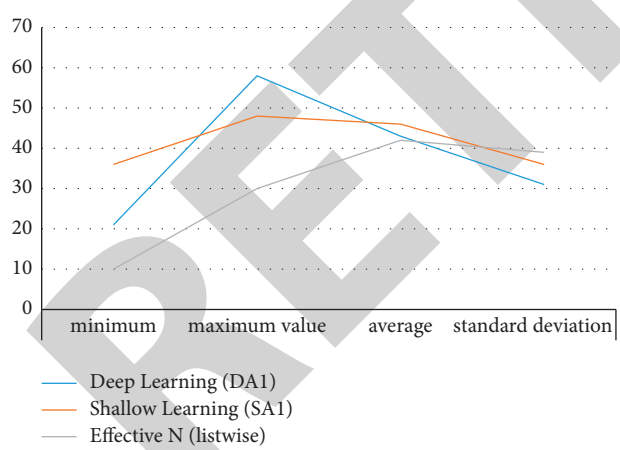

Figure 2: Descriptive statistics of the results of the second questionnaire test.

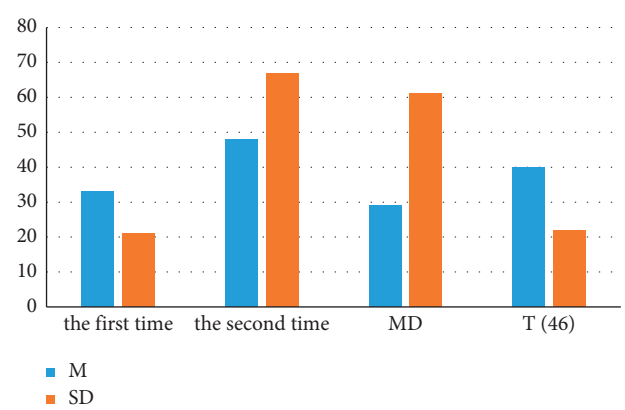

Figure 3: Deep learning paired sample test.

students' learning motivation and learning style, and students who adhere to this view, learning participation and learning outcomes may be less affected by PBL courses. In terms of teaching, students' suggestions reflect the consistency of PBL learning characteristics and students' learning needs, including keeping pace with the times, strengthening the connection with current hotspots and students' future development, and focusing on the cultivation of English skills, enriching personal statements and evaluation methods, etc., However, through the content of the interviews, the students suggested that more emphasis should be placed on the teacher's guidance and explanation, that is, the English skills to improve the skills are explained separately in the course. And think that improving English is difficult. Learning efficiency is only through self-study. The explanation is divided into two parts before and after PBL learning, which can make better use of the benefits of teacher education and students' cooperative learning and self-

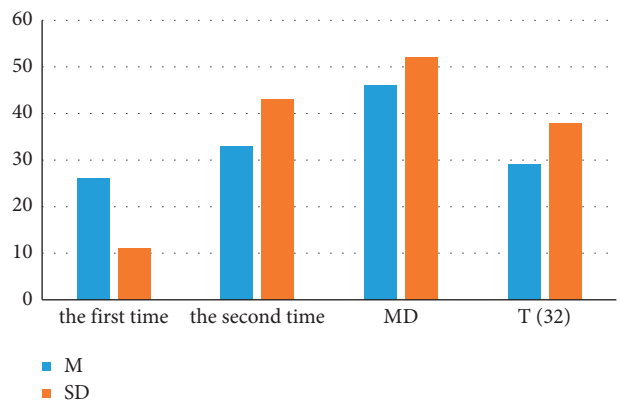

Figure 4: Shallow learning paired sample test.

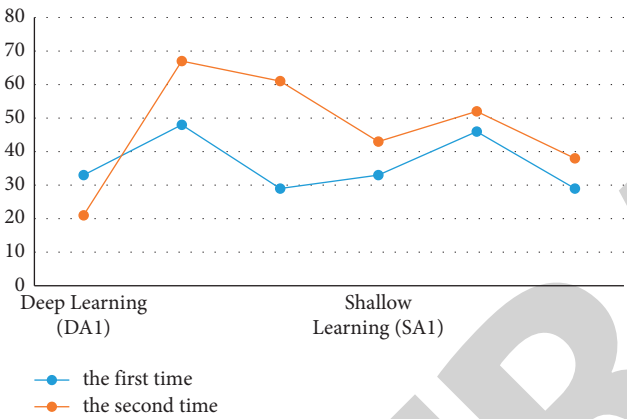

Figure 5: Comparison of samples before and after deep learning and shallow learning.

directed learning. Combining the results of PBL assignment analysis and student interviews, it can be concluded that while students may not be able to guide themselves in deep learning through metacognitive strategies when learning English, PBL students may be trained to use it. Deep learning methods help students perform deep learning to solve poorly structured real-world problems. In addition, according to the interview results, PBL questions may respond more to the learning needs of retirees in addition to language learning, but more factors will affect students' learning outcomes and final learning outcomes in PBL learning. Factors such as motivation, specific study schedules, and targeted learning tools. Therefore, students' learning influence is mainly manifested in cognitive level awareness, reading strategy skills, collaborative learning, deep learning, and so on. Numbers and deep learning are unclear and require further analysis.

5. Conclusion

By analyzing questionnaires, interviewing English teachers and analyzing classroom observation records, this study found the main problems affecting the deep learning of English reading courses and the cultivation of core English literacy. The correct understanding of core literacy training awareness and the role of deep learning and the function of English courses need to be strengthened. Reading class needs to be improved in terms of improving the comprehensive ability of language use and cultivating core qualities such as learning ability, emotional experience, thinking quality and cultural character. Secondly, teachers and students are utilitarian in English reading teaching goals, shallow in goals, test-oriented in content, solidified in teaching methods, outdated in programs, and simplified in evaluation, which hinders the development of deep learning and the realization of core literacy goals. Thirdly, using information technology to optimize teaching content, highlighting students' main body to optimize teaching process, and reforming standards and perspectives to optimize teaching evaluation are effective ways to promote in-depth learning of English reading courses and the development of students' core literacy. But how much of an impact it will have, we have not discussed any further, and we do not have enough data to prove it. If time permits, we can further improve the positioning of this paper from the following aspects: first, conduct experimental research to verify the feasibility of different evaluation methods; and second is to study the evaluation of "students with disabilities."

Data Availability

The experimental data used to support the findings of this study can be obtained 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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Retraction

Retracted: Design of the Music Intelligent Management System Based on a Deep CNN

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] J. Shang and F. Shao, "Design of the Music Intelligent Management System Based on a Deep CNN," *Security and Communication Networks*, vol. 2022, Article ID 1559726, 9 pages, 2022.

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Research Article

Design of the Music Intelligent Management System Based on a Deep CNN

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Music is a common art form in people's life, and it is closely related to people's living conditions. Since ancient times, music has been closely related to people's lives. The music intelligent management system is convenient and user-friendly, and it can meet the demand for music. However, it has major flaws. Collaborative filtering algorithm can achieve the recommendation performance of music intelligent management system, which can recommend the same type of music to users with related preferences. Deep learning technology has developed relatively maturely, and it has been successfully applied in people's life and production. Deep convolutional neural network (CNN) techniques can extract deeper features than simple CNN techniques. Although there is a weak nonlinear relationship between people's behavioral characteristics and living habits and the music intelligent management system, the advantage of deep CNN technology is to deal with the nonlinear relationship between large amounts of data. This study uses deep CNN technology to extract the relationship between people's living habits, living environment, and behavior characteristics and the music intelligent management system. The deep CNN technology helps the music intelligent management system to further realize the active recommendation function of the music intelligent management system. The research results also show that the deep CNN technology has good feasibility and high accuracy in the music intelligent management system. It can well map the relationship between people's behavioral characteristics and living habits and the music intelligent management system. The deep CNN technology can also realize the active recommendation function of the music intelligent management system. For the prediction of the music intelligent management system, the largest prediction error is only 2.17%. This part of the error is for the prediction of song genres. The prediction errors for the other two features are both within 2%.

1. Introduction

With the continuous improvement of people's living standards, music has become a common way of life entertainment. Music can release and express people's emotions [1, 2]. If a person is in a bad mood, it can be vented in the form of music. Similarly, if a person is happy enough, he can also release his emotions in the form of music. Music has entered people's lives. Music has accompanied people's lives since ancient times. It is not only an art form but also an artistic sustenance for people to express their thoughts and feelings [3, 4]. In ancient times, people would express music in the form of books or musical instruments. However, with the advancement of technology and the advancement of various APP software, the recording of music can already be reflected through intelligent management systems, such as QQ Music, NetEase Music, and other music intelligent management systems. People can listen to and record their favorite forms of music and the words expressed in music through the music intelligent system. Each music intelligent management system will have its own advantages and prominent forms. People's pursuit of music intelligence software is also different [5, 6]. For example, some people like the interface form and the intelligent management system of QQ Music, and some people also like the simple interface of NetEase Music. However, this fondness stems from a love for music. The QQ Music and NetEase Music intelligent management systems are already the representatives of music management systems. They have collected a large number of music songs, which have different forms and

different eras of music. Music lovers can find their favorite music according to their own preferences and pursuits. The music intelligent system can also design a different form of music according to different time and different working places. This means that the music intelligent system has achieved a better level according to the habits and pursuits of music lovers. At the same time, the current music intelligent system has also realized the function of speech recognition, which can find suitable music songs and music expressions according to people's speech needs [7]. In general, the current music intelligent system has achieved a more detailed and more accustomed way. It is more convenient, and it can find suitable music forms according to the needs of different groups of people. However, the current music intelligent management system also has certain defects. It cannot implement music recommendations based on people's behavioral habits. This means that the music intelligence system still lacks a more intelligent music recommendation system. It can be understood that the music intelligent management system cannot realize the matching and playing of music forms according to people's behaviors. For the life of modern people, this is also a function that is urgently needed by the music intelligent management system. With the advancement of people's living standards and the level of science and technology, people's lives continue to develop in the direction of intelligence and automation. People's pursuit of the comfort of life is also constantly improving. The initiative of the music intelligent system is also an important direction.

Big data technology has developed to a relatively mature stage. It has functions such as speech recognition, image recognition, and active recommendation [8]. It is also used in many fields of life and production. If the big data technology is applied to the music intelligent management system, it can assist the music intelligent management system to realize the active recommendation function, which is also a relatively new way [9]. The deep convolutional neural network technology (CNN) in big data technology can better complete the data mapping relationship [10, 11]. If deep CNN technology is used to map the relationship between music lovers' behavior and living environment and the music intelligent management system, it can improve the function of the music intelligent management system, which is also a better application direction. Deep CNN technology has been relatively easy to implement in today's rapid development of hardware devices. Big data technology can capture data related to people's living habits and hobbies, and it can also map the relationship between these related data and the music intelligent management system. This can efficiently and accurately establish the relationship between people's life behavior and the music intelligent management system.

Deep CNN technology is also a variant of CNN, and CNN already has good compatibility in deep learning training platforms [12, 13]. Deep CNNs have deeper network layers and more computational parameters. They can extract features of deeper research objects. Compared with shallow CNN, deep CNN has higher accuracy in dealing with more complex features. It already allows us to build any desired forms of CNN. Deep CNN technology can identify deeper features. There are relatively complex features for the behavioral characteristics, living environment, and other characteristics of music lovers and the recommendation of the music intelligent system, which is a mapping relationship that is difficult to achieve with shallow CNNs. This is because people's behavioral habits and the environment have changed greatly, which means that there are relatively large fluctuations in characteristics. This requires more data to provide more features, in order to learn the nonlinear relationship between people's behavioral habits and the recommendations of the music intelligent management system. However, the major defect of the deep CNN is that it has more parameter operations, which requires higher computing power of the computer. The implementation of the deep CNN needs to pose a greater challenge to the performance of GPU [14].

The acceleration ability of GPU for the deep CNN is obvious. However, the CNN also has certain advantages; that is, it has a certain weight sharing mechanism, which greatly reduces the computational complexity of parameters compared with fully connected neural networks and long-short-term memory neural networks. At the same time, the behavioral characteristics, living environment, and music intelligent management system involved in this study have little temporal correlation, so this study did not use long-short-term memory neural networks to map the temporal correlation between features. In order to improve the utilization and calculation speed of the computer and GPU, this study only considers the use of deep CNN technology in the music intelligent management system.

This study uses deep CNN technology to extract the characteristic relationship between music lovers' behavior, living environment, and living habits and the music intelligent management system. Moreover, this research uses the collaborative filtering algorithm to realize the active management of the music intelligent system, which accepts the output data of the CNN. This study will present relevant introductions from the following five aspects: Section 1 mainly introduces the research significance of the music intelligent management system, the existing defects, and the research significance of deep CNN technology. It also introduces the significance of the fusion of deep CNN technology and the music intelligent management system. The related research status of music management is illustrated in Section 2. Section 3 mainly analyzes the design scheme of deep CNN technology in the music intelligent management system and the working principle of deep CNN technology. Section 4 introduces the feasibility of applying deep CNN technology in the music intelligent management system in the form of the average error and scatter plot. Section 5 describes the relevant conclusions of the application of deep CNN technology in the music intelligent management system.

2. Related Work

Although the music intelligent management system has achieved great success, it can make corresponding music recommendations according to people's needs. The music

intelligent management system is also a large market demand. However, there are still great improvements and deficiencies in the transliteration intelligent management system. Many researchers have also conducted a lot of research on music management. Cheng [15] used the teaching task of music appreciation in a middle school in Zhejiang to design a multimedia teaching system with environmental requirements by means of an object-oriented method. This multimedia technology music system includes the functions of music online teaching, music retrieval, student management, and design of music. It can reasonably improve the teaching environment for students to learn music, and it can also improve students' interest in music learning. The results show that this music multimedia technology improves students' music appreciation ability. This has improved a certain reference value and reference for the school's music teaching and management. Hu and Yang [16] have found that school music teaching has the problems of few courses and lack of music management. In order to improve students' interest in music learning, it uses deep learning technology to study its role in music teaching management. It uses deep learning models to verify the accuracy of traditional music as well as mobile music and current music courses, as well as accuracy in image recognition. The research results show that the combination of the music teaching model and deep learning is a feasible technology. Under the influence of deep learning models, music courses offered by schools will also increase. This has a great effect on improving students' interest in music and mastering the art of music. Garcia-Peinazo [17] explored the role of podcasting technology in teaching music situations. Through podcast technology, students can understand, experience, and examine the advantages and differences between Western music art and Chinese music art. Podcasting technology also promotes the way students mediate and manage music. Finally, it also discusses the importance of podcasting technology for music teaching. The findings suggest that this technology can facilitate the development of music teaching, and it can also improve students' interest and understanding of music. Liu [18] also found that music was also an important part of colleges and universities. Informatization has also entered the management of colleges and universities. It thinks that the information construction and the management of music in colleges and universities have great defects. This research mainly uses the embedded multicore processor to study a set of the music information management system in colleges and universities. The system was also tested and trained using machine learning algorithms, and traditional music systems suffer from low accuracy. This music information system can achieve high accuracy, and it can achieve efficient and stable operation. Zhang et al. [19] analyzed the relationship between music data and users with the help of the NetEase cloud music management system. It mainly analyzes the source of NetEase cloud data and the relationship between the creator's data and users. These data also include data about user clicks, likes, and followings. The database and management mode of NetEase cloud can provide more reference value for the research of other music management systems. This is mainly reflected in the connection between NetEase cloud's database and users. Zhang [20] designed a fog computing model for the resource management system of music and dance. This model will use Internet of things technology to effectively classify the resources of music and dance. It also improves the traditional NSGA-II (fast nondominated sorting genetic algorithm-II) algorithm to test and study the problem of music and dance resource allocation. The research results show that the improved NSGA-II algorithm has better performance in music and dance resource management, and it has relatively stable performance. This research focuses on realizing the active recommendation technology of the music intelligent management system according to people's living habits and changes in living environment, and it adopts the intelligent algorithm of the CNN.

3. Application of Deep CNN Technology in the Music Intelligent Management System

3.1. The Significance of Deep CNN Technology. Deep CNN technology can extract deeper features of research objects. However, deep CNN technology has more complex parameter computations than shallow CNN technology. There is a complex relationship between the music intelligent system and the behaviors and living environment of music lovers, which requires deep CNN technology to extract the relationship between the music management system and the research object. This can lead to underfitting if a shallow CNN technique is used. In the process of mapping the music intelligence management system and behavioral features, it will cause the loss function to be in a high position. However, it will also be in a steady state. This can easily lead to misjudgment by researchers. This is because the shallow CNN cannot extract more features. Deep CNN technology generally has more than 5 layers, and it also has a large number of filters. As the feature extraction process continues to iterate, the number of filters will continue to decrease. Shallow CNN techniques have been widely used in many fields. The first is that there is a relatively simple nonlinear relationship between them. The second possibility is that the research subjects have relatively low requirements for prediction errors. Deep CNN technology also has high requirements on the number of datasets.

3.2. The Principle of the Deep CNN Technology in the Design of the Music Management System. The overall goal of this research is to use deep CNN technology to extract the behavioral characteristics, living environment characteristics, and living habit characteristics of music management systems and music lovers. In addition, this research study maps the nonlinear relationship between the music management system and these three characteristics. Ultimately, it will utilize deep CNN technology to implement active recommendation technology for music management systems. Active recommendation means that the music management system can recommend music and turn on music according to people's behavior changes, changes in living environment,

and music lovers' habits. Most of the current music management system is a passive management mode, which will only make a series of responses and music output according to people's needs and active access to the music management system. The music management system of the active recommendation mode will realize the tasks of active opening and active recommendation of the music management system according to the real-time changes of these three characteristics. This music management system with active recommendation function is more intelligent. In order to achieve the recommendation performance of the music intelligent management system, it adopts an object-based collaborative filtering algorithm. It can recommend the same type of music to users with specific related habits and behavioral preferences. Figure 1shows the application scheme of deep CNN technology in the music intelligent management system. The input data of this study are people's living habits, hobbies, and living habits, and the label data are the music duration, song name, and music type. Deep CNN technology will extract the features of these three kinds of data. Then, this study also utilizes a coordinated filtering recommendation algorithm, which will recommend music that matches the characteristics. This study used deep CNN technology to realize the active recommendation technology of the music intelligent management system. Once the model of the deep CNN and collaborative filtering algorithm is trained, it can realize real-time music recommendation according to people's behavioral characteristics, changes in living environment, and changes in people's habits. These music recommendations may include data such as the type of music, the songs of music, and the broadcast duration of music. After extracting the characteristics of life-related factors of people in this study, it will output data such as the type of music and song name, which will be actively recommended by the music intelligent management system.

The deep CNN technique is also a variant of the CNN method, which will include multiple layers of CNN structures. Most deep CNN techniques will contain more than five CNN layers. The deep CNN will extract more musical features, behavioral features, and environmental change features. Figure 2 shows the workflow of the deep CNN, which is also a one-layer CNN structure in deep CNN technology. CNN also has the same basic structure as the perceptron, and it also uses the distribution of weights and biases to realize the mapping of nonlinear relationships. There are also many similarities between the CNN and the fully connected neural network. It also uses the loss function to calculate the difference between the predicted value and the actual value. It also uses gradient descent to find the direction of gradient descent for the weights. The weight sharing mechanism allows CNN to develop towards a deeper level.

For the deep CNN, the input layer needs to undergo convolution operations, which is the difference from fully connected neural networks. Equation (1) shows the calculation method of the input layer of the deep CNN, which will include convolution and matrix operations.

$$V = \mathrm{conv2}\left(W, X, {}''\mathrm{valis}''\right) + b. \tag{1}$$

Equation (2) shows the output computation of the deep CNN, which is the output after feature extraction of multiple layers of CNN, which also requires nonlinear transformation of the activation function.

$$Y = \phi(V). \tag{2}$$

Equation (3) shows the computational algorithm for a layer of the deep CNN. Convolution operations and feature flipping will be involved here. Equation (3) shows the calculation method for feature flipping 180°. The feature filling operation will also be involved here. For missing features, it will run in a filling way.

$$\delta^{l-1} = \mathrm{con}v2\left(\mathrm{rot}180\left(W^{l}\right)\delta^{l}, {}'\mathrm{full},\right)\phi'\left(v^{l-1}\right). \tag{3}$$

The loss function is a function that every neural network must have. It will be responsible for calculating the size of the error between the predicted value of the model and the actual value, which will affect the direction and trend of gradient descent. The loss function stops iterating until the model converges. Equation (4) shows one way of calculating the mean squared error.

$$E = \frac{1}{2}\left(d_{\mathrm{out}} - O_{\mathrm{real}}\right)^{2} = \frac{1}{2}\sum_{\kappa=1}^{t}\left(d_{\kappa} - O_{\kappa}\right)^{2}. \tag{4}$$

Equation (5) shows a derivation calculation criterion for the weights. The derivative calculation is to find the direction of gradient descent.

$$\Delta u_{ij} = -\eta\frac{\partial E\partial}{\partial u_{ij}}. \tag{5}$$

3.3. Application of Coordinated Filtering in the Music Intelligent Management System. In this study, after deep CNN technology has extracted music features, behavioral features, and environmental features of music lovers, it can map the nonlinear relationship between the music management system and people's behavioral features. This research utilizes the collaborative filtering algorithm to realize the active recommendation function of the music management system. The deep CNN will only complete the mapping of nonlinear relationships, and the collaborative filtering algorithm will actively recommend the corresponding music and duration of the music management system based on these relationships. The content recommended by the collaborative filtering algorithm is the information that users are more concerned with. Collaborative filtering algorithms are mainly divided into object-based collaborative filtering algorithms and user-based filtering algorithms according to their functions. An object-based collaborative filtering algorithm recommends music with similar characteristics to users. This study adopts an item-based recommendation algorithm. A collaborative filtering algorithm is an important recommendation system, which can recommend users or objects. Application in the music intelligent management system can recommend music types and songs according to people's living habits and other characteristics.

The goal of the collaborative filtering algorithm is to find similarities between data. Equation (6) shows that the data use the cosine of the included angle to calculate the distance

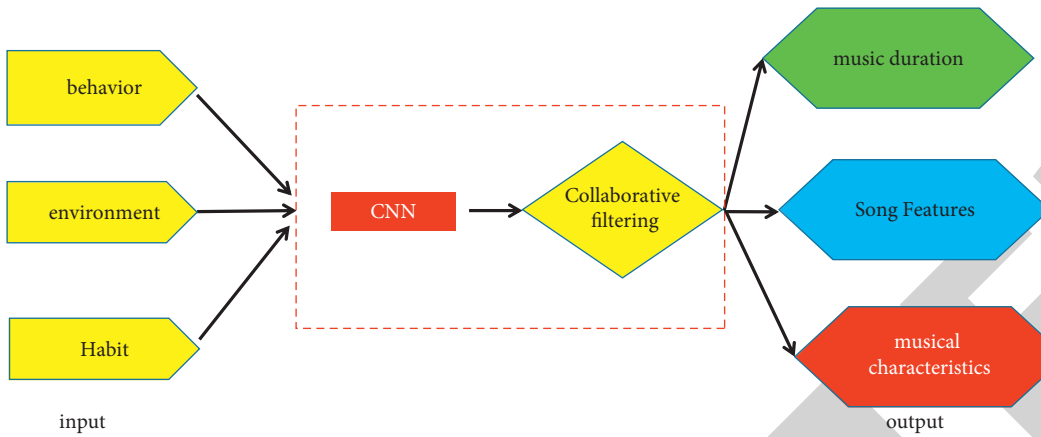

Figure 1: Application scheme of deep CNN technology in the music intelligent active recommendation system.

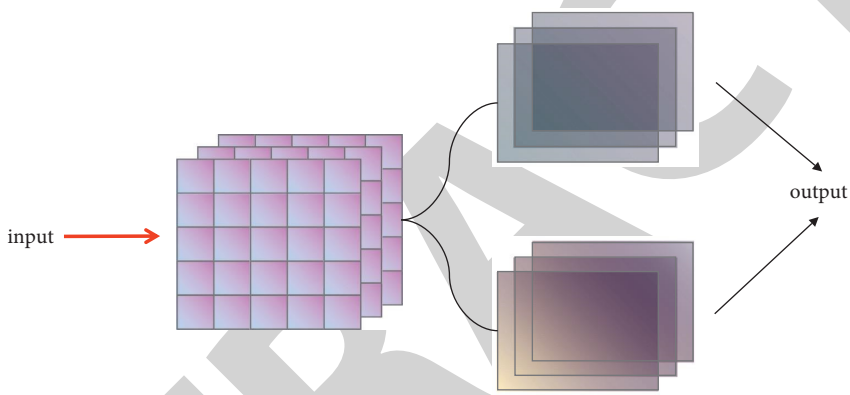

Figure 2: Workflow of the deep CNN.

between the data. Equation (7) is an expanded form of Equation (2). The cosine of the included angle is a common way of solving the distance in collaborative filtering algorithms.

$$\cos\theta = \frac{a \bullet b}{|a||b|}, \tag{6}$$

$$\cos\theta = \frac{\sum_{k=1}^{n} x_{1k} x_{2k}}{\sqrt{\sum_{k=1}^{n} x_{1k}^2}\sqrt{\sum_{k=1}^{n} x_{2k}^2}}. \tag{7}$$

Equation (8) presents a similarity method calculation value criterion based on user associations. It needs to calculate the Pearson-r correlation of the data characteristics of the two subjects. When calculating the similarity between datasets using the cosine of the similarity angle, it needs to consider the influence between datasets. Equation (9) shows how the similarity is calculated when this effect is taken into account.

$$\mathrm{sim}(i, j) = \frac{\sum_{u \in U}\left(R_{u,i} - R_i\right)\left(R_{u,j} - R_j\right)}{\sqrt{\sum_{u \in U}\left(R_{u,i} - R_i\right)^2}\sqrt{\sum_{u \in U}\left(R_{u,j} - R_j\right)^2}}, \tag{8}$$

$$\mathrm{sim}(i, j) \frac{\sum_{u \in U}\left(R_{u,i} - R_u\right)\left(R_{u,j} - R_u\right)}{\sqrt{\sum_{u \in U}\left(R_{u,i} - R_u\right)^2}\sqrt{\sum_{u \in U}\left(R_{u,j} - R_u\right)^2}}. \tag{9}$$

Equation (10) shows how the weighted similarity of datasets is calculated. Such weights refer to similar information about different subjects.

$$P_{u,i} = \frac{\left(s_i * R_{u,N}\right)}{\left|s_{i,N}\right|}. \tag{10}$$

4. Result Analysis and Discussion

This study uses deep CNN technology to map the relationship between the behavioral characteristics, environmental characteristics, and habitual characteristics of music lovers and the music intelligent management system. After the deep CNN completes the relevant feature extraction, it will use the collaborative filtering algorithm to complete the active recommendation technology of the music intelligent management system. This music intelligent management system consists of two parts. One part is to complete the prediction of relevant features, and the other part is to complete the active recommendation of music. The dataset used in this study comes from actual data from multiple universities, which will ensure the accuracy and practicability of the model. The data on living habits and music-related characteristics used in this study were derived from research data in Beijing. When the data are collected, they

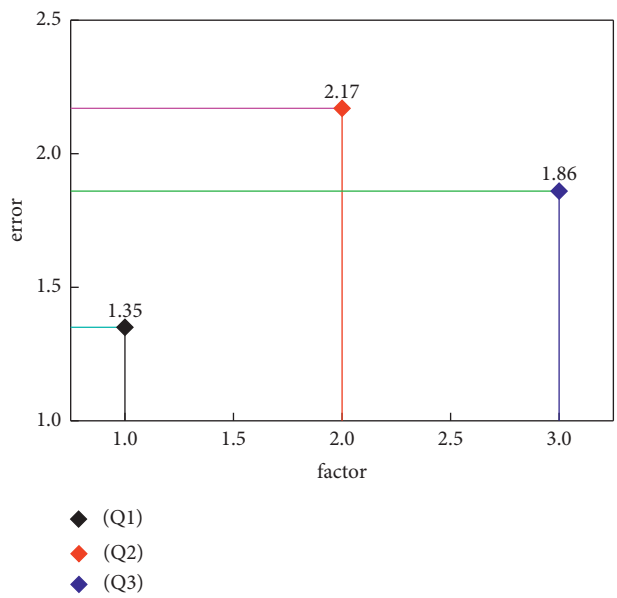

Figure 3: Prediction error of the collaborative filtering algorithm in the music intelligent management system.

need to be divided into behavioral, environmental, and habitual characteristics of music lovers. The data of the recommendation function of the music intelligent management system will be divided into music form recommendation, song type recommendation, and music duration recommendation. This is the key to the music intelligent management system.

In this section, the first part will introduce the accuracy of the collaborative filtering algorithm. It will output the recommended duration of music, music type, and song type. The active recommendation function of the music intelligent management system mainly uses people's behavioral information to recommend music-related features. Figure 3 shows the recommendation accuracy of the collaborative filtering algorithm. Q1 represents the prediction error of the recommended duration. Q2 represents the prediction error of the song genre. Q3 represents the recommendation error of the music genre. Overall, the collaborative filtering algorithm has high accuracy in recommending the relevant features of the three types of music based on people's behavioral information. The recommendation error for music duration is only 1.35%, and the recommendation of music duration is relatively easy. The music duration has a relatively large fixed feature, and it does not fluctuate much because everyone basically listens to music during the day or evening; the probability of listening to music at night is relatively low. This forms a certain habit characteristic. The recommendation error of the song type is relatively large. This part of the error reached 2.17%. There are relatively large fluctuations in the type of songs, and it will also be updated in real time.

Through the above analysis, it can be found that the song type and music type are relatively difficult to predict for the collaborative filtering algorithm. This study selected 15 sets of data to investigate the accuracy of the deep CNN

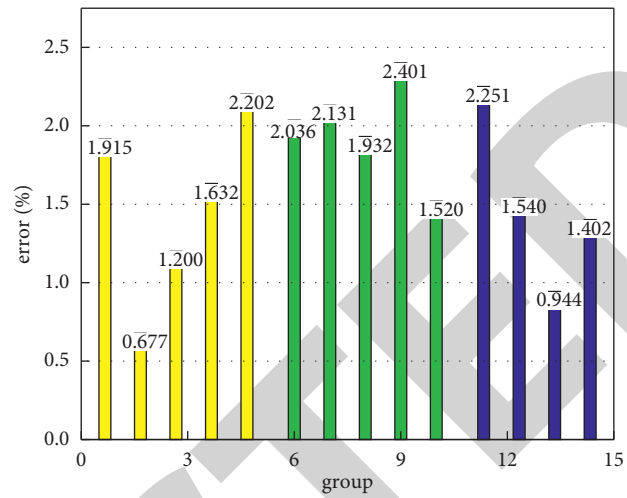

Figure 4: Prediction error distribution of song features using the deep CNN methods.

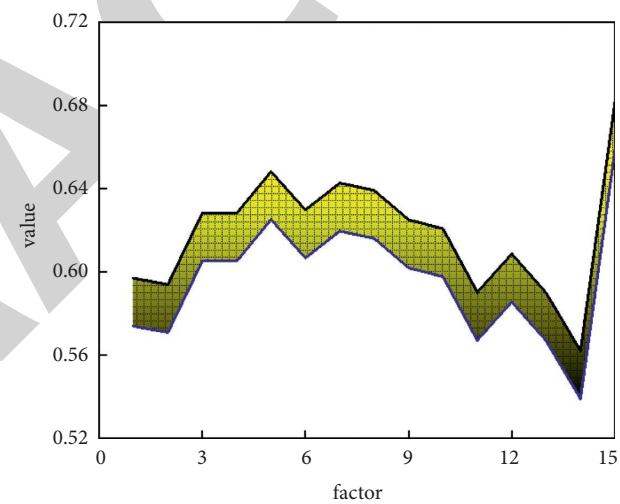

Figure 5: Distribution and change of predicted and actual values of song features.

techniques in predicting music-related features for three predictive features. Figure 4 shows the distribution of prediction errors for song features for 15 test sets. The yellow histograms represent the data from the first 5 test sets. The blue histogram represents the data of the next 5 test sets. In conclusion, this study divided 15 sets of test set data into 3 groups of histograms with different colors for analysis. Overall, all prediction errors are distributed within 2.5%, which is a sufficiently accurate prediction error for the music intelligent management system. Most of the errors are also distributed within 2%, with only five sets of data having prediction errors exceeding 2%, which range from 2% to 2.5%. There are large differences in song characteristics for different populations. For the same person, there is a greater correlation between song features and the environment and behavior. At the same time, songs are constantly updated over time, which leads to large fluctuations in song characteristics. This error can also prove that the deep CNN

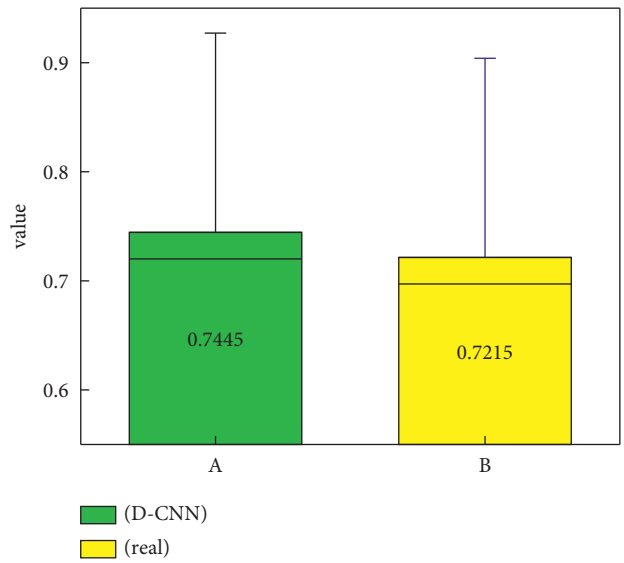

Figure 6: Box distribution of predicted and actual values of music genre features.

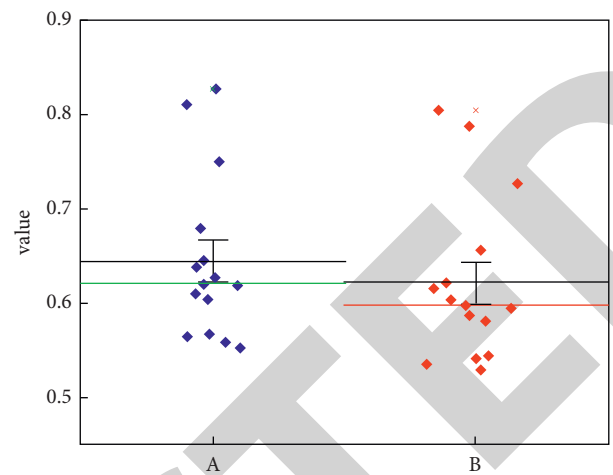

Figure 7: Distribution of predicted and actual data points for music duration features.

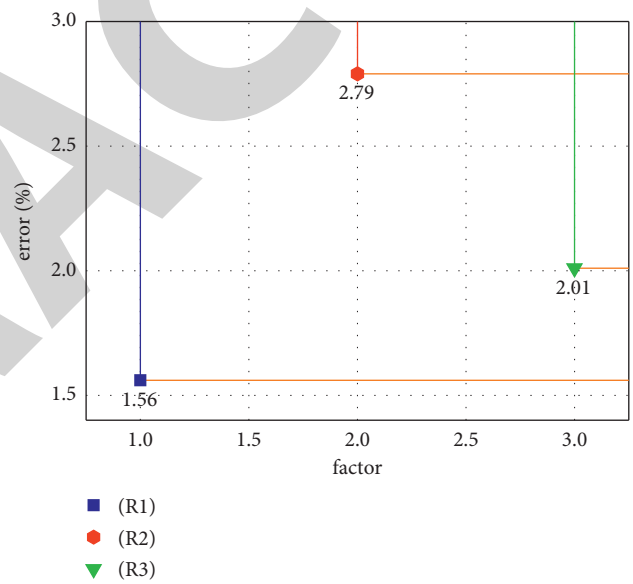

Figure 8: Average prediction error of three features of the music intelligent management system using the deep CNN method.

technology can be trusted in the music intelligent management system. There are also a small percentage of prediction errors within 1%, which may be a less demanding group of songs.

Through the analysis of Figure 4, it can be found that there is a strong temporal correlation between song features. The songs in the music intelligent management system are constantly changing. Therefore, this study also investigates the deep CNN method in predicting the changing features of song features over time. Figure 5 shows the distribution of predicted and actual values of song features. The yellow area is the error between the predicted value of the song feature value and the actual feature value. In general, the predicted values of song features have a high degree of agreement with the actual values. Although there are large fluctuations in song characteristics at different times, deep CNN technology can still effectively predict the fluctuation characteristics of song characteristics, which show the feasibility and effectiveness of deep CNN technology in music intelligent management systems. In the early days of the forecast, there is a relatively large error here. However, in the later stages of song feature prediction, this error gradually decreases.

The distribution of the box can visually display the distribution of the predicted value and the actual value, including the average value and the distribution of all values. There are also large fluctuations in music genres for different groups. This is also related to changes in the environment. This makes musical features more difficult to predict. Figure 6 shows the bin distribution of the predicted and actual values of music features. In general, there is a large similarity between the predicted value of the music feature and the actual value of the box. The difference between the predicted value and the mean of the actual value is also relatively small. This can also demonstrate the feasibility and dependability of deep CNN techniques in predicting musical features of music management systems.

For the three characteristics of the music intelligence system, the music duration is the easiest to predict for people who like music and listen to music at a fixed time. For people who have a certain interest in music, the duration of this part of the music is more difficult to predict. Figure 7 shows the predicted distribution of music duration features. Green and red areas represent the mean distribution of music duration features. The black line represents the median distribution of the music duration feature. The blue area represents the distribution of the predicted value of the music duration, and the red dots represent the distribution of the actual value of the music duration. Overall, the blue and red areas have relatively similar distributions, and the value in the blue area is close to the value in the red area, which means that the predicted value of the music duration feature is close to the actual value. This can further

illustrate that the deep CNN method can also successfully predict the music duration characteristics in the music intelligent management system. Figure 8 shows the relative mean error distribution of the deep CNN technique in predicting three characteristics of the music management system. On the whole, most of the errors also meet the needs of the intelligent music management system, and the largest prediction error is only 2.79%. This part of the prediction error is the prediction error of song features, which is also the most difficult to predict. However, the prediction of this part of the characteristics has already met the needs of the music management system.

5. Conclusions

Since ancient times, music has always existed in people's lives in the form of an artistic feature. With the advancement of technology, numerous music management systems have emerged, which can meet people's needs for different types of music. It also allows more people to go to the fascination of the music field. Although the music system can meet most people's needs, it is a passive management system. The current music management system has an active recommendation function, which is the so-called active recommendation of music. This research uses the deep CNN method and the collaborative filtering algorithm to realize the active recommendation technology of the music intelligent management system, which can actively recommend music according to people's behavior, environment, and habits.

In this study, it first uses the deep CNN to extract people's behavioral information, environmental characteristics, and habitual characteristics to map the music duration, music characteristics, and song characteristics of the music intelligent management system. In general, deep CNN technology has high feasibility in the music intelligent management system. All prediction errors are within 3%. The lowest prediction error is only 2.79%. This part of the error mainly comes from the prediction of song features, which is also the most difficult part of the entire music intelligent management system to predict. The second step is to use the collaborative filtering algorithm to realize the active recommendation technology of the music intelligent management system. The collaborative filtering algorithm has also reached a certain level in the music intelligent management system. For the recommendation research of the three characteristics of the music intelligent management system, all the prediction errors are also within 3%.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Retraction

Retracted: Psychological Consultation and Health Analysis Method for Artificial Intelligence Multidecision Support

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Psychological Consultation and Health Analysis Method for Artificial Intelligence Multidecision Support

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With the increase in market economy and life competition, mental health problems are particularly prominent in today's society. This is also an important reason for the sudden increase in extreme events. The frequent occurrence of violent incidents and depressive incidents is mainly caused by major problems in mental health. They accumulate greater pressure in life or study, which can easily lead to mental health problems. However, mental health problems are difficult to detect up front. When the mental health problem is more serious, they will seek a psychological counselor or a way to release stress to solve the mental health problem. Only a small number of people will take extreme measures, which will cause social or family losses. Artificial intelligence methods have better advantages in dealing with nonlinear relationships of features. This study uses a convolutional neural network (CNN) and long short-term memory (LSTM) methods in artificial intelligence methods to study the characteristics of psychological counseling and health. The research results show that CNN and LSTM methods can accurately predict the characteristics of psychological counseling and health, which can do certain forecasting work for discovering people's mental health problems. The maximum prediction error of CNN and LSTM methods in predicting the characteristics of psychological counseling and health is only 2.64%.

1. Introduction

With the improvement of social productivity and the pace of life, people's psychological pressure has also fluctuated greatly. In this day and age, mental health is an important topic. The incidence of violent incidents as well as extreme incidents has gradually increased with the improvement of living standards [1, 2]. There is a strong correlation between the occurrence of extreme events and mental health. Mental competition is one of the main causes of unhealthy minds. In the 1960s–1990s, extreme events were less likely, mainly because living standards were lower and there was less competition [3, 4]. At the same time, people's sense of life is relatively happy, although the quality of life is relatively low. However, people's lives are relatively satisfactory. There is also less competition between people, and people also have lower psychological stress. This allows people to maintain a relatively healthy mind. From this point of view, a healthy mind is very important both for an individual and for a country. Students are also a relatively large group in life. Students may have depression or other extreme behaviors, which are mainly caused by greater academic pressure and employment pressure. The life of games and comparisons can easily lead to extreme unhealthy behaviors in students. These two are also sources of lower learning pressure for students [5, 6]. In previous years, students rarely come into contact with so many kinds of life and games. For employees of large enterprises, the timeliness pressure of work and the pressure of life can easily cause greater psychological pressure [7, 8]. In order to improve the productivity of products, enterprises often increase production efficiency by squeezing the time of employees. For employees, the pressure of life, the pressure of enterprise production, the pressure of children's education, and other issues lead to poor mental health problems. Enterprises in previous years will not face the pressure of life and market competition in

today's era, and it will reduce the pressure on employees. Middle-aged people, they have to face the pressure of children's education and starting a family, and they also have to face the pension problem of the elderly. This requires them to put in more labor in exchange for a return. In the process of labor, they will spend more time and energy to labor for more rewards, which also reduces their rest time. This is also the source of their mental health problems. It can be seen from the above description that different groups will face different pressures, whether it is young people or middle-aged people. These pressures come from different sources. Once they get more stress, it can cause them to have unhealthy psychological problems. Unhealthy psychological problems can easily lead to some extreme events. This is also the phenomenon of a surge in extreme events. Therefore, people's mental health is a focal issue that deserves attention. The best way is to reduce people's mental health problems through psychological counseling or stress reduction.

In today's society, most of the commonly used decompression methods are through psychiatrists or looking for some ways to release pressure. The way to release stress is different for different groups of people. Psychological counseling is also a common method. It will slowly find the factors that cause more stress through the guidance of the psychological counselor, and then people will use certain methods to avoid the occurrence of stress or reduce the damage caused by stress to mental health. However, in most cases, it can be found that when people's mental health problems reach extremes, they will seek psychological counselors or decompress through some stress-releasing methods. This is equivalent to the late stage of mental health problems [9, 10]. This stage of mental health problems is already a relatively serious stage. It can only solve short-term stress problems by relying on psychological counselors or stress-releasing methods, but in the long run, It is also a potential mental health problem. When people encounter a flashpoint for a mental health problem, that long-standing mental health problem can easily trigger extreme events. When it comes to mental health issues, the best way to do this is to stay in a good mood all the time. When a mental health problem is found, it needs to solve the problem in a reasonable way to reduce the occurrence of mental health problems.

It is difficult for people to discover their psychological problems in time through their own cognition and habits. Most people have little awareness of mental health problems. This can easily lead to an advanced state of mental health problems. Artificial intelligence technology has developed rapidly, and it may be helpful for psychological counseling and health problems. Artificial intelligence technology is good at dealing with huge amounts of data, and it can also mine correlations between related data from huge amounts of data [11, 12]. The development of mental health problems is related to many factors, and the initial performance of mental health problems is also related to many factors [13, 14]. Artificial intelligence technology can look for the relationship between these factors and mental health problems. Although the relationship between these data is complex, however, artificial intelligence technology can extract deeper features by deepening the network layer, which is also allowed by the technology. Artificial intelligence technology can deal with spatial features, temporal features, and features related to the environment. These three features can basically meet the needs of people's life and production feature extraction. There are already many kinds of algorithms in artificial intelligence technology, which allow people to build different artificial intelligence frameworks with fundamentally different data characteristics and different research objects, which is a more flexible and convenient way. Among artificial intelligence methods, CNN and LSTM methods are the two most common methods. They can deal with the spatial and temporal characteristics of the research object, respectively. These two methods have relatively high stability that benefits from a wide range of applications.

This study uses artificial intelligence technology to explore the problems of psychological counseling and health. The artificial intelligence algorithms used in this study include CNN and LSTM, which can efficiently extract the temporal and spatial characteristics of factors related to psychological counseling health problems. In active mental health and counseling tasks, artificial intelligence methods can extract more mental reference content for people. It can also help people to predict mentally relevant feature data. It can look for mental health relationships that cannot be established by artificial means. This study demonstrates the feasibility of applying artificial intelligence algorithms in psychological counseling and health through 5 sections. Section 1 introduces the research background of mental health issues and the development of artificial intelligence technology. Section 2 describes the current state of research on mental health issues. The scheme design of artificial intelligence methods for mapping and prediction of mental health and counseling-related features is studied in Section 3. Section 4 focuses on the prediction accuracy of CNN as well as LSTM methods in terms of mental health-related features. In Section 4, this study analyzes the accuracy of the CNN-LSTM approach to mental health and counseling features using mean error plots, prediction error scatter plots and prediction box plots. This is the core part of the research. Section 5 summarizes the research and analysis of the full text.

2. Related Work

Mental health problems not only affect the life and work of an individual but also affect the overall development of a country. However, there is a certain degree of uncertainty about mental health problems, which leads to a potential crisis of mental health problems. Numerous researchers have explored the characteristics and discovery strategies associated with mental health problems. Skinner et al., [15] conduct research and simulations on students' mental health issues. It mainly analyzes students' perceptions of mental health problems and it studies the prediction of students' mental health problems. It uses statistical learning methods as well as tests of independence and linear regression to analyze mental health issues between students and exams.

The results of the study showed that there was a relatively large correlation between anxiety characteristics and mental health problems in exams. This simulation method can guide students' anxiety relationship with exams, allowing them to discover the specific meaning of mental health problems in time. Xiao et al., [16] believed that traditional psychological counseling and health problems are mainly focused on the treatment of psychiatric disorders, which involves the privacy of patients. This study used a two-factor model to investigate the relationship between mental health problems and psychiatric pathology. It explores the applicability of two-factor models to mental health issues. Its research objects are mainly aimed at college students. The results show that the two-factor model has a higher fitting coefficient in dealing with college students' psychological counseling and health problems. At the same time, this model can also propose a screening scale for mental health problems. This method can bring a certain sense of happiness to the psychology of college students. Bjornsen et al., [17] considered mental health education an important part of the school's practical curriculum. This study mainly analyzed the relationship between positive mental health literacy (PMeHL) and students' mental health. It explores this relationship between mental health using a multiple linear regression approach along with an associated covariate approach. Its research objects are mainly from adolescents, mainly because adolescents' psychology is prone to greater fluctuations. The findings found smaller gender differences in mental health problems. The regression model has certain feasibility in exploring the mental health problems of adolescents. This study provides a certain method for mental health education in schools. Seo et al., [18] studied the benefits of nonservice programs for mental health issues in the community and remediation issues in the mental health community. It selected multiple patients with mental health problems to study the issue. It mainly measures characteristics such as social communication aspects and clinical variables of these individuals. It uses the method of structural equations to test this hypothesis. The findings suggest that community resources are easier to access, which means less mental health problems. The festive mood can also affect symptoms in people with mental health conditions. McAlpine et al., [19] believed that self-assessment of mental health problems is a better way to improve quality of life and reduce morbidity. This method has certain advantages over traditional mental health treatment, which is also due to the fact that people have less awareness of mental health knowledge. The results of the study found that 62% of the mentally ill are relatively positive. In the absence of mental health treatment, positive things can promote the improvement of their mental health problems. Javed et al., [20] considered mental health issues to be an emerging global health problem. 80% of mental health problems are found in low- and middle-income countries. This study analyzes factors contributing to mental health problems in low- and middle-income countries. Culture, as well as socioeconomics, contribute to varying degrees of mental health problems. Individual behaviors and attitudes and inadequate health systems can also contribute to mental health problems. Primary treatment systems for mental health problems as well as interventions in public places can reduce the occurrence of mental health problems. Most of the researchers mainly explored the related factors of mental health problems, and a few researchers explored the initial findings of psychological counseling and health. There has been less research on artificial intelligence approaches to mental health issues.

3. Application Design and Introduction of Artificial Intelligence Methods in Psychological Counseling and Health

3.1. Implications of AI Methods for Psychological Counseling and Health. Mental health problems are a relatively hard-to-find symptom in the early stages. Many people are also reluctant to admit the disease. However, mental health problems are also relatively easy to occur, which are mainly related to the pressure of work and life. In today's fast-paced world, there is an even greater need to pay attention to mental health issues [21]. Mental health problems are closely related to people's behavior, speech, and pulse. However, people's awareness of mental health problems is relatively low. This can easily lead to the accumulation of mental health problems, which can then lead to extreme events. This has a negative impact on individuals as well as society. How to predict the occurrence of mental health problems based on people's behavior or speech is important research. Artificial intelligence methods are an advantageous way of predicting mental health problems. It can look for the relationship between people's behavior, speech, and mental health problems. With enough data, artificial intelligence methods can find the relationship between people's behavior and mental health problems. Not only can this predict the occurrence of mental health problems it can also estimate the level of mental health problems.

3.2. Psychological Resources and Health Intelligence System Design and CNN Introduction. This study is mainly to explore the prediction and grade prediction of mental health problems based on people's behavior, speech, and pulse. This will design an intelligent psychological consultation and prediction system. This system can not only predict the occurrence of mental health problems based on people's daily behavior, but it can also prevent the occurrence of mental health problems. This system can also provide psychological counseling services. It can provide some knowledge related to psychological counseling according to the needs of different groups of people with psychological problems. Most people are reluctant to go to a psychologist for psychological counseling because of their privacy habits. The psychological counseling and health system designed in this study can not only predict people's psychologically related health problems but also provide psychological intelligent counseling according to people's needs. After the data set of mental and health counseling is collected, this study will digitize these characteristics. Then, the data preprocessing algorithm will divide the dataset into three

feature datasets according to the distance correlation. Figure 1 shows the design of CNN and LSTM methods for psychological counseling and health prediction. For CNN and LSTM algorithms, it requires a large amount of data to learn psychological counseling and health-related features. As a first step, this requires providing the intelligent system with a large amount of mental health data about people's behavior, speech, and pulse. Once these data have undergone relevant preprocessing, they need to be input into the CNN. CNNs can learn the relationship between these characteristics of people and mental health characteristics. The characteristics of mental health mainly include the occurrence of psychological problems and the level of health. After these data are learned by CNN, they need to be input into the LSTM algorithm. This is because mental health issues are a problem that builds up over time, and it has a strong relationship with time.

Mental health problems are not simply triggered by one thing, which is related to a change in time. The CNN algorithm can better map the relationship between people's behavior, speech, and mental health characteristics, but it cannot extract time-related features. Therefore, this study considers the use of LSTM methods to extract the temporal features of mental health and the temporal features of people's speech. The LSTM method has been successfully applied in the field of speech recognition. In the intelligent system of psychological counseling and health, people's mental health problems are also long-term accumulation problems. People will have normal behavior and speech in the beginning. However, it experiences greater stress over time. This can slowly lead to the emergence of mental health problems. Different people also have different attitudes to stress, which also affects the emergence of mental health problems. Therefore, this study needs to use the LSTM method to extract the temporal features of mental health features. If the LSTM method is not adopted, this will result in inaccurate extraction of mental health features. Figure 2 shows the workflow of the LSTM method for predicting and extracting features for counseling and health. It mainly contains multiple gate structures. In Figure 2, the input layer of the LSTM will feed the data of the output layer of the CNN. This data will be fed into the LSTM as a time series. The output data is mental health and counseling-related information. The most important thing about the LSTM method is the four-gate structure. It will select and filter historical information and current information through the gate structure. After passing through different gate structures, it will input the historical information with a greater weight to the next layer of the network.

3.3. CNN Algorithm and Corresponding Formula Introduction. Mental health problems are more specifically related to people's behavior, speech, and pulse. It is a nonlinear mapping relationship between x and y. CNNs have good performance in mapping features. It can first complete the feature extraction task, and then it can complete the feature mapping relationship. In this study, this refers to the discovery of mental health problems and the relationship between ratings and behavioral traits such as people's behavior, speech, and so on. The CNN method has been successfully applied in many fields of mapping relations, no matter how complex these relations are, it can complete the mapping of relations. If there is an overly complex relationship between mental health-related features and the features of people's behavior and speech, it can complete the extraction of deep features by deepening the number of network layers.

First, this study introduces the relevant computational pipeline of the LSTM method. Equation (1) shows how the forget gate of LSTM works. The forgetting gate is mainly aimed at the selection of information at the previous moment. It can select the information of the previous moment according to the weight and enter the next stage of learning through the neural network.

$$f_t = \sigma\left(w_f \bullet \left[h_{t-1}, P_t\right] + b_f\right). \tag{1}$$

Equations (2) and (3) show the method of the input gate of the LSTM method. The input gate can input two kinds of data, which are the data of the previous moment and the current moment. It is also selected by the size of the weights.

$$i_t = \sigma\left(W_{xi} * x_t + W_{hi} * h_{t-1} + W_{ci} \circ C_{t-1} + b_i\right), \tag{2}$$

$$f_t = \sigma\left(W_{xf} * x_t + W_{hf} * h_{t-1} + W_{cf} \circ C_{t-1} + b_f\right). \tag{3}$$

The output of the output gate will be connected to the next LSTM layer. This also outputs some data related to the next moment. Equations (4) and (5) show how the output gate is calculated. This gate structure also contains layers of activation functions. *ht* is the output layer of the LSTM layer and it represents the nonlinear relationship. C_t contains linear relationship data, and its data are transformed into data with nonlinear relationship through the excitation function.

$$o_t = \sigma\left(W_{xo} * x_t + W_{ho} * h_{t-1} + W_{co} \circ C_t + b_o\right), \tag{4}$$

$$h_t = o_t \circ ELU\left(C_t\right). \tag{5}$$

Equations (6) and (7) show the equations of the CNN's loss function. The loss function mainly calculates the predicted and actual eigenvalues of mental health predictive features. The MSE loss function is a relatively common loss function, which has high stability and convergence performance. And the MSE method is more suitable for the distribution form of psychological and health counseling characteristics.

$$L = MSE\left(q^{\text{real}}, q^{\text{pre}}\right) = \frac{1}{nm}\sum_{k=1}^{N}\sum_{j=1}^{M}\left(q_{kj}{}^{\text{real}} - q_{kj}{}^{\text{pre}2}\right), \tag{6}$$

$$E = \frac{1}{2}\left\|d - y^L\right\|_2^2. \tag{7}$$

Equation (8) shows how the input layer of the CNN is computed. The input layer of CNN is different from other neural networks. It requires a convolution operation, and the

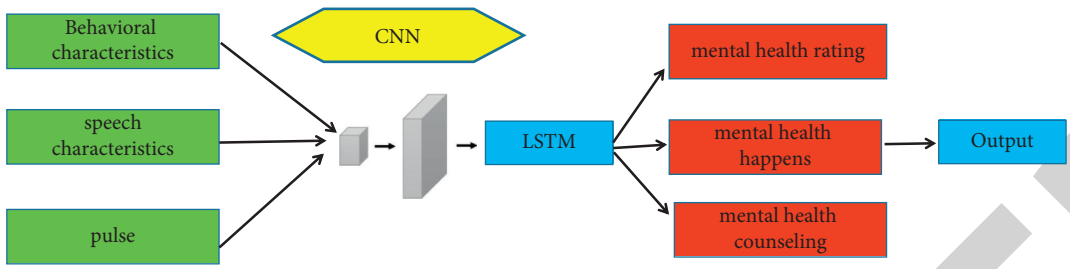

Figure 1: Solutions of CNN and LSTM in psychological counseling and health system.

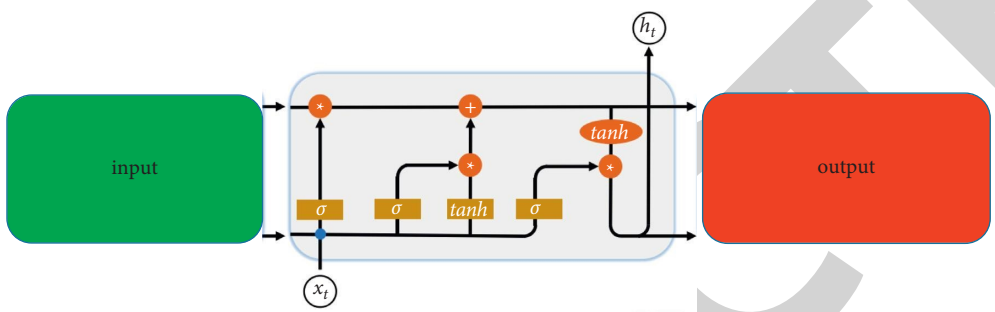

Figure 2: Introduction to the working principle of the LSTM method.

convolution operation also means that the factors of some hidden layers do not participate in the calculation of parameters.

$$a^2 = \sigma\left(z^2\right) = \sigma\left(a^1 * W^2 + b^2\right). \tag{8}$$

Equation (9) shows one calculation of the pooling layer, which is also deformed from Equation (8).

$$a^l = \text{pool}a^{l-1}. \tag{9}$$

Activation functions are an integral part of every neural network. Equation (10) shows the calculation formula of the activation function. It can nonlinearized the number of mental health traits.

$$a^l = \text{Re}LU\left(z^l\right) = \text{Re}LU\left(W^l a^{l-1} + b^l\right). \tag{10}$$

If there is a certain probability selection in the output of CNN, this requires the use of the softmax function of Equation (11), which is for classification problems. Activation functions are an essential part of artificial intelligence methods. If the activation function is not used in the prediction of psychological and health counseling-related features, it is difficult to obtain the correlation between psychological and health counseling features, which is only an expression of a linear relationship.

$$a^l = \text{softmax}\left(z^l\right) = \text{softmax}\left(W^L a^{L-1} + b^L\right). \tag{11}$$

4. Result, Analysis, and Discussion

This study makes full use of CNN and LSTM methods to explore the characteristics and applications of psychological counseling and health intelligence systems. It is mainly based on people's behavior, speech, and pulse changes to find the emergence of mental health and the level of mental health problems. At the same time, it can timely push psychological counseling-related knowledge according to people's needs, which are customized and pushed according to each person's needs. This involves the mapping relationship between people's behavior, speech, pulse, mental health level, and psychological counseling methods, and it also involves the relationship between people's psychological change characteristics and time. This requires the use of CNN and LSTM methods. The LSTM method mainly extracts the temporal features of mental health features. This study collected data on behavioral characteristics and mental health of 2000 groups of people in Shenzhen. Shenzhen is an area where life and work pressure are relatively high, so it can be relatively simple to collect relevant data. After the data collected, the data need to be preprocessed according to the relevant characteristics.

In this study, first compares the accuracy of two neural networks in mental health feature extraction. It first uses a neural network without LSTM layer to extract the characteristic relationship between mental health and people's behavior, which can find out whether there is a certain correlation between changes in mental health and time. Figure 3 shows the prediction errors for three related features of mental health using a neural network without LSTM layers. V1 represents the prediction error of people's speech information. V2 represents the prediction error of behavioral information. V3 represents the prediction error of people's pulse-related features. Of the three errors, the prediction error for the first two features has exceeded 2%. However, it is all within 3%. From the perspective of mental health-related characteristics, this error is also adequate. However, the errors in these three behavior-related

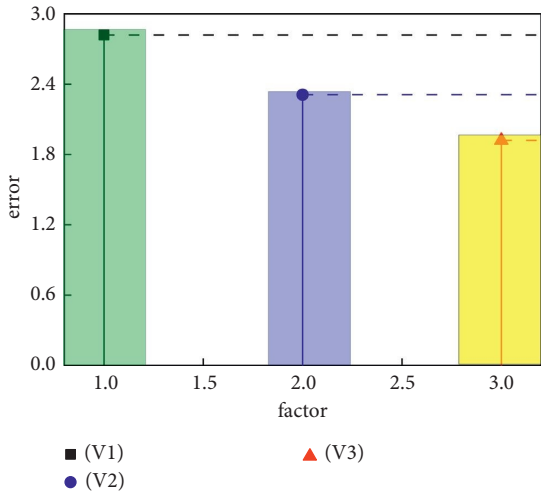

Figure 3: Prediction errors of three features associated with mental health problems using neural networks without LSTM layers.

characteristics of people are also too large. Especially for people's verbal information, this error has reached more than 2.8%. There are large temporal characteristics of people's speech behavior, which have an important impact on the behavior of mental health problems. This may be the reason for the large error in this part of the feature.

The LSTM layer can extract the temporal features of mental health and counseling-related features, which is a more favorable idea. This study also investigated the prediction error of a hybrid neural network algorithm for mental health and counseling-related characteristics. Figure 4 shows the prediction errors for three characteristics of mental health using a hybrid CNN and LSTM approach. Overall, the prediction errors of people's behavior, speech, and pulse characteristics are significantly improved relative to the use of no LSTM. This is more favorable for the prediction of mental health and counseling. This also shows that the characteristics of mental health and counseling problems have obvious temporal characteristics, which have been effectively proved. This also shows that mental health and counseling problems are a result of the accumulation of time. The characteristics of mental and health counseling contain more time characteristics. It is difficult for CNN to extract temporal features of research objects. The LSTM method has specific and obvious advantages in extracting the characteristics of psychological and health consultation time, so this part of the error has been significantly reduced. Speech features, which are some of the mental health features with larger temporal features, their prediction error reduced from 2.8% to 2.13%. The error of behavioral characteristics information related to mental health was reduced from 2.29% to 1.94%. The prediction error of the pulse feature was reduced from 1.87% to 1.41%. This part of the reduction is also relatively large. This shows the effectiveness of the LSTM method in predicting mental health characteristics. Prediction errors of people's behavior and pulse characteristics were reduced to less than 2%. The prediction error distribution of these three characteristics is extremely beneficial for timely detection of mental health and accurate psychological counseling matching. Therefore, temporal characteristics need to be fully considered when predicting characteristics related to mental health and counseling.

Through the abovementioned description, it can be found that people's speech characteristics are the characteristics that affect mental health and counseling intelligent systems. In this study, the prediction errors of 20 groups of speech features were selected for prediction accuracy analysis. Figure 5 shows the distribution of prediction errors for psychological counseling and healthy speech characteristics. In Figure 5, the green area represents the prediction error of mental and health counseling within 2%. In this way, the prediction error distribution of language features can be seen more intuitively. In Figure 5, the red dashed line represents the data with a larger prediction error for the verbal characteristics of mental and health counseling. The red dotted line can clearly see the distribution of large prediction errors. Overall, CNN and LSTM methods have high feasibility in predicting speech features. Most errors in speech features are distributed within 2%. Only 3 sets of data exceeded the 2% prediction error, as shown in red in Figure 5. This occupies a relatively small part of all test sets. Overall, CNN and LSTM methods can better predict the verbal characteristics of mental health and counseling. There is also a small part of the error distribution within 1%, which also shows that CNN and LSTM methods can better grasp the verbal characteristics of mental health and counseling.

Behavioral characteristics are also an important part of the characteristics that affect mental health and counseling systems. This is because mental health problems are often manifested through people's behavioral characteristics. For the intelligent system of mental health and counseling, it is crucial to accurately predict people's behavioral characteristics, which is crucial for accurately predicting the occurrence and level of mental health. Figure 6 shows the distribution of predicted and actual values for behavioral characteristics of mental health and counseling. This study uses the form of box plots to display, which can show the distribution and value of mental health-related data. From the overall perspective of the box, the predicted value of behavioral characteristics of mental health is larger than the actual behavioral value. However, this error is also relatively small. CNN and LSTM methods can better predict the distribution characteristics and size of data values of behavioral characteristics of mental health. The distributions of the peaks and medians of the behavioral characteristics are almost identical. Errors were mostly found in the trough portion of mental health behaviors. There is a small deviation here. The predicted value of the behavior characteristic is close to the mean of the actual value. Overall, CNN and LSTM methods are feasible solutions in intelligent systems for mental health and counseling. In Figure 6, it can be clearly seen that the predicted value of the behavioral feature value of psychological and health counseling is larger than the actual value, mainly because the training process of the CNN-LSTM method is more ideal than the actual environment, and it has less noise impact.

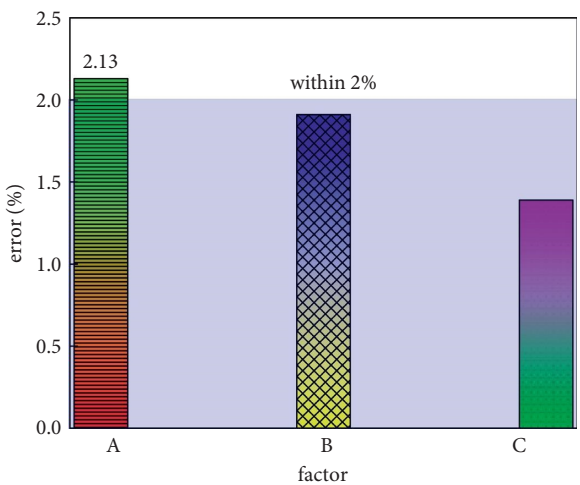

Figure 4: Prediction errors of three features associated with mental health problems using neural networks with LSTM layers.

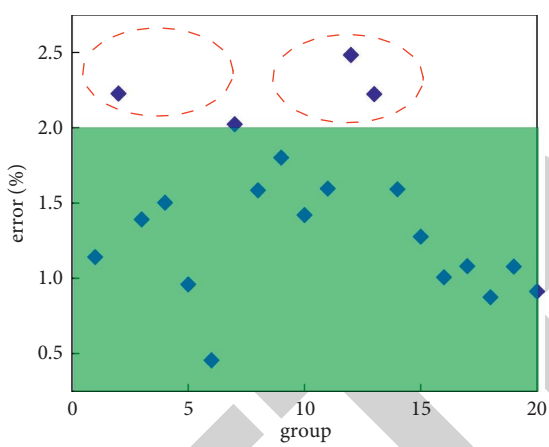

Figure 5: Prediction error distribution of verbal features in mental health and counseling.

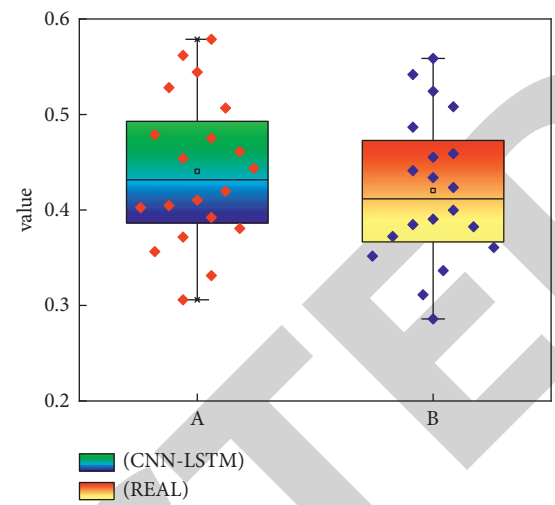

Figure 6: Distribution of predicted and actual values of behavioral traits in mental health and counseling.

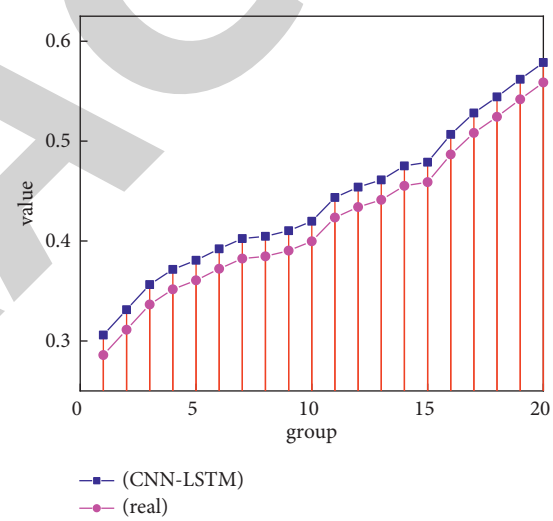

Figure 7: Distribution of predicted and actual values of behavioral pulse in mental health and counseling.

Pulse changes are the most intuitive way to reflect mental health problems. This feature also has the smallest mean error for the three features of mental health. Figure 7 shows the distribution of predicted and actual values of the mental health pulse characteristics. It can also be seen from Figure 7 that the eigenvalues of mental health have relatively small fluctuations compared with speech and behavioral characteristics. In Figure 7, the blue line represents the predicted value of the pulse feature, and the red line represents the actual data value of the pulse feature. The area between the red and blue lines represents the prediction error for this feature. And the prediction errors of the pulse eigenvalues are relatively close to 20 different sets of data. CNN and LSTM can easily predict the pulse characteristics of mental health. This shows that the mental health and counseling intelligent system can predict the occurrence and level of mental health according to the changes in pulse characteristics. For practical situations, this is also the most intuitive way. Overall, through the above research, it can be found that CNN and LSTM methods can more accurately predict the speech, behavior, and pulse characteristics of mental health. This is beneficial for timely detection and tracking of people's mental health problems, and this intelligent prediction system is also credible.

5. Conclusions

Psychological counseling and health problems have become a hot research topic in today's society, which is mainly related to the frequent occurrence of extreme events. This not only involves some social personnel, but it also involves student groups. This situation is detrimental to the development of the country and society. However, there is a certain incubation period for mental health problems, and the occurrence of extreme events is not caused by temporary mental health problems. However, the mental health and counseling system in today's society is not very sound, which

makes people unable to recognize their own mental health problems in time and get timely and effective release. The development of artificial intelligence technology is relatively rapid, it can efficiently deal with huge amounts of data, and it can also map nonlinear relationships. This study applies artificial intelligence technology to an intelligent research system for mental health and counseling. Traditional methods make it difficult for people to learn about their own mental and health-related knowledge. Everyone's situation is different, and artificial intelligence methods can recommend relevant knowledge about mental and health counseling based on people's behavior and words.

This research mainly adopts two kinds of neural network algorithms, CNN and LSTM, which are popular in the field of artificial intelligence. It can complete the extraction of mental health and counseling-related features and complete the feature mapping task. For this study, it will map the relationship between people's behavior, speech, and pulse and the generation and hierarchy of mental health. These three characteristics are also important factors in identifying mental health problems. This study also explored the effect of the presence or absence of LSTM neural network on the prediction of mental health and counseling-related characteristics. Overall, neural networks with LSTM layers will have higher accuracy in predicting mental health-related characteristics. The main differences emerged in the behavioral characteristics of people related to mental health. For the CNN and LSYTM methods, the maximum prediction error for mental health and counseling is only 2.13%. This is derived from people's speech characteristics. This part of the characteristics is the most difficult for mental health prediction. Prediction errors for behavioral and pulse characteristics were within 2%. This is a favorable error distribution for timely discovery of mental health problems and timely intelligent psychological counseling. Overall, the mental health and counseling intelligent system designed in this study has high feasibility and credibility. The CNN-LSTM method has higher accuracy in predicting the characteristics of psychological and health counseling, it can more accurately guide people to predict mental health problems, and it can also more accurately provide guidance for psychological prevention. This has a certain innovative significance for guiding mental health and counseling. This study uses artificial intelligence methods to predict characteristics related to psychological and health counseling, which has good practical value. It can better guide people to prevent and solve psychological problems.

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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Retraction

Retracted: High-Quality Development of Leisure Agriculture in Jiangsu Province in the New Period: From the Perspective of Non-Technological Innovation

Security and Communication Networks

Received 13 September 2023; Accepted 13 September 2023; Published 14 September 2023

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Li and L. Li, "High-Quality Development of Leisure Agriculture in Jiangsu Province in the New Period: From the Perspective of Non-Technological Innovation," *Security and Communication Networks*, vol. 2022, Article ID 1293821, 9 pages, 2022.

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Review Article

High-Quality Development of Leisure Agriculture in Jiangsu Province in the New Period: From the Perspective of Non-Technological Innovation

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How to innovate leisure agriculture in the new period is the core issue in the high-quality development of leisure agriculture. The research holds that whether it is the macro "trend of leisure agriculture system supply", the middle "characteristics of leisure agriculture industry itself" and the micro "characteristics of leisure agriculture enterprises", it is the rational choice to choose non-technical innovation for the high-quality development of leisure agriculture in the new period. With the acceleration of technological innovation, the importance of non-technical innovation has become increasingly prominent. The organization for economic cooperation and development (OECD) and the European Statistical Office (Eurostat) have not only expanded the definition of innovation, but also increased marketing innovation and organizational innovation. These two kinds of innovations are not technological innovations in themselves, but they are of great significance to the growth of productivity and economic development. Taking Jiangsu as the research area, it took two years (2020–2021) to conduct a field survey on 31 representative leisure agricultural enterprises in seven cities of southern, central and northern Jiangsu. The results showed that non-technological innovation factors were the key to these representative enterprises' competitive advantage, but it was also found that Jiangsu leisure agricultural enterprises needed systematic support from non-technological innovation to "excellence". Based on industrial economics, technological innovation economics and evolutionary economics, this paper tries to build a non-technological innovation system of leisure agriculture in Jiangsu province, and puts forward some countermeasures and suggestions for the high-quality development of leisure agriculture under the system construction from two dimensions of government and enterprises.

1. Introduction

Industrial revitalization is the top priority of rural revitalization. Leisure agriculture is a new form of agricultural production and management that uses agricultural landscape resources and agricultural production conditions to develop sightseeing, leisure and tourism. It is a new way to deeply develop the potential of agricultural resources, adjust the agricultural structure, improve the agricultural environment and increase farmers' income. In the comprehensive leisure agricultural area, tourists can not only sightseeing, picking fruits, experiencing farming, understanding farmers' life and enjoying local interests, but also accommodation and vacation. As an important part of rural industry, the high-quality development of leisure agriculture is related to the effective promotion of rural revitalization and the modernization of agriculture and rural areas. After the report of the 19th National Congress of the Communist Party of China in 2017 put forward that China's economy has shifted from a high-speed growth stage to a high-quality development stage, on April 13th, 2018, the Ministry of Agriculture and Rural Affairs specially issued the Notice on Developing Leisure Agriculture and Rural Tourism Upgrading Action for the high-quality development of leisure agriculture, which marked the clarion call for the high-quality action of leisure agriculture. Later, both the

rural industry development plan and the rural revitalization promotion law emphasized that leisure agriculture is an important component of rural industry revitalization. In 2021, the No. 1 document of the Central Committee made it clear that the high-quality development of agriculture should be driven by innovation, and the high-quality development of leisure agriculture as a modern agriculture must also pay attention to innovation. Since 2016, Jiangsu has begun to pay attention to the innovation of leisure agriculture, and successively issued policy documents such as "Opinions on Accelerating the Construction of a Strong Leisure and Sightseeing Agriculture Province" and "Opinions on Accelerating the Development of Creative Agriculture", striving to build Jiangsu into a strong leisure agriculture province with leading industrial scale benefits, leading demonstration creation level and leading development quality. Actively introduce advanced leisure and tourism concepts, strengthen independent innovation, and explore and form a characteristic leisure and tourism agricultural development model. We should pay attention to the diversification of agricultural structure, speed up the development of animal husbandry, seed and seedling, and agricultural product processing industry, improve the level of agricultural industry, and improve the overall quality and comprehensive benefits of leisure and sightseeing agriculture from the perspective of the comprehensiveness and coordination of the development of agricultural industry. Strengthen the contact and coordination between departments to provide active and effective guidance and services for the healthy development of leisure and sightseeing agriculture. Academic research on the high quality and innovation of leisure agriculture mainly started in 2019. According to the existing research, there are more studies in a specific urban area, but less macro studies above the provincial level. To sum up, the main countermeasures and suggestions mainly focus on "business model innovation", "concept innovation" and "management innovation". High-quality agriculture must be driven by innovation, and leisure agriculture is no exception. This study holds that the high-quality development of leisure agriculture must be a systematic problem, including micro-enterprises, medium-level industries and macro-level institutional arrangements. Starting from the top-level design of leisure agriculture, establish a leisure agriculture planning system with clear ideas, clear tasks and obvious characteristics. Strive to promote the development of leisure agriculture as a national industrial development strategy, deepen the understanding of the significance of developing leisure agriculture, and guide the healthy development of leisure agriculture. According to the actual and regional characteristics of various regions, we should further improve the existing policy documents to make them more scientific and universal, and better guide and promote the construction and development of leisure agriculture. Only by considering innovation from a systematic perspective can it meet the needs of the high-quality development of leisure agriculture under the current "double-circulation" strategy in China and the normalization of COVID-19 epidemic.

2. Innovative Choice of High-Quality Development of Leisure Agriculture in the New Period

2.1. Innovation and Non-Technical Innovation System. Joseph Alois Schumpeter was the first economist to put forward the concept of innovation. He believed that the fundamental phenomenon of economy is development rather than equilibrium, and the root of development lies in innovation. It is believed that innovation includes five main aspects: creating a new product, adopting a new production method, opening up a new market, acquiring or controlling a new supply source of raw materials or semi-finished products, and realizing a new organizational mode [1]. If the current category of NTI (non-technological innovation) probably includes business model innovation, value chain innovation, management innovation, organizational culture innovation and institutional mechanism innovation, then the last three aspects of the five innovations actually refer to non-technological innovation, which shows that the first innovation consists of both technological innovation and non-technological innovation. With the development of economy and society in the later period, countries have found that non-technical innovation plays a more and more important role in economic and social development [2]. Friedman put forward in 1992 that innovation not only includes technological innovation, but also includes non-technical innovations such as business model, organization and management. The third edition of Oslo Manual, jointly published by OECD and Eurostat, more systematically expounds the role of non-technological innovation in enterprise strategy, internal management and external relations, and includes non-technological innovation in innovation data collection [3].

Reasons why high-quality development of leisure agriculture should focus on non-technical innovation in the new period.

In 2010, Document No. 1 of the Central Committee clearly put forward that "actively develop leisure agriculture, rural tourism, forest tourism and rural service industry, and expand rural non-agricultural employment space". At the national level, the development plan specifically for leisure agriculture is the 12th Five-Year Plan of National Leisure Agriculture Development issued by the Ministry of Agriculture in August, 2011. This plan marks the transformation of leisure agriculture from the National Tourism Administration to the Ministry of Agriculture. Subsequently, in order to further accelerate, strengthen and promote the development scale of leisure agriculture, the Ministry of Agriculture issued the Notice on Further Promoting the Sustainable and Healthy Development of Leisure Agriculture on November 26th, 2014 [4]. If the above systems are mainly to promote the expansion of leisure agriculture development scale, then the Notice of Upgrading Leisure Agriculture and Rural Tourism on April 13th, 2018 indicates that the development of leisure agriculture should change from quantity to quality. From the five points of the content, apart from improving public facilities, the others are

"cultivating excellent brands", "improving service level" and "inheriting farming culture" Since then, the related systems of leisure agriculture have been continuously strengthening the supply of non-technical innovation of leisure agriculture. After 2016, Jiangsu proposed to strengthen the creativity of leisure agriculture, and the specific content basically focused on strengthening the non-technical innovation of leisure agriculture. After that, the institutional supply also focused on the non-technical innovation of leisure agriculture [5].

Leisure agriculture is the result of industrial integration. From the classification of industrial integration, leisure agriculture is a typical example of internalized industrial integration, which moves, extends and integrates the original agricultural industrial value chain, and internalizes the external division of labor of agricultural industry. This internalization is more embodied in "service". On the one hand, from the industrial level, leisure agriculture industry is the extension or turn of the value of traditional agriculture industry, and then forms "industrial service"; on the other hand, from the enterprise level, leisure agriculture enterprises are the "service" of agricultural enterprises to the original products [6]. Therefore, whether from the perspective of industry or enterprise, its essence is to bring the economic activities that have certain internal correlation with agriculture into agriculture, and then create value together with other economic activities, and finally bring economic benefits beyond the traditional agriculture itself [7]. The external manifestation of figuration is different because of different industries or different angles of expanding the internal functions of agriculture, and the product forms formed are also rich and diverse. Our traditional farming culture and art have natural origins, such as our ancient farming instruments, daily necessities, sacrificial activities, folk songs, performance activities and so on, which are constantly summarized, created and transformed by the hardworking Chinese people in the process of long-term labor practice. With more emphasis on tourism aesthetics, agriculture has become one of the important sources of artistic landscaping, such as colorful flower fields, rice field paintings, crop circles, tea terraces, rice field mazes and other artistic agricultural landscapes. "Rice field painting" is the result of the integration of agriculture and creative industries, and "homestay" is the result of the integration of agriculture and tourism industries [8]. At the same time, industrial integration means breaking the original industrial boundaries and expanding the business content to other unfamiliar industrial boundaries. In practice, it is necessary to break the original framework to rebuild relevant policies, platforms, models and organizational forms, all of which are non-technological innovations [9].

Traditional agricultural innovation is characterized by complexity, uncertainty and long periodicity. Therefore, in order to reduce the risk of technological innovation, most agricultural enterprises mostly adopt R&D externalization or only participate in a certain link of innovation, which means that the technological innovation of most traditional agricultural enterprises comes from outside. In addition, what is common with general agricultural enterprises is that leisure agricultural enterprises are more likely to apply the results of agricultural technological innovation than to rely on themselves [10]. However, the biggest difference is that leisure agriculture is an innovative form that breaks the traditional agricultural primary production framework, and includes the innovation of secondary and tertiary industries that traditional agricultural enterprises do not have. It is a "destructive innovation" and an innovation that breaks away from the old "framework" of enterprises. As for experience service, one of the core products of leisure agriculture, it means that the production and processing of traditional agriculture are directly or indirectly participated by tourists, and the production process and consumption process are synchronized [11]. Now most young people, children and a large number of urban people have long been divorced from rural life and know nothing about the traditional rural farming culture, but our farming culture and some farming activities have great attraction for them. Therefore, we need to deeply tap the farming culture, combine farming activities with leisure tourism and vacation, and inherit the farming civilization through the farming experience of hometown and original customs. Consumers are both producers and consumers, which also determines that the non-technological innovation of leisure agriculture enterprises is more important than technological innovation. In addition, at present, leisure agriculture is dominated by small and medium-sized enterprises, which are constrained by capital, scientific research, manpower and other aspects and are difficult to carry out technological innovation [12]. Therefore, it is obviously rational for leisure agriculture enterprises to focus on non-technological innovation.

3. Investigation on Non-Technical Innovation of Leisure Agriculture in Jiangsu Province

The scale of Jiangsu's leisure agriculture ranks in the forefront of the country, and the number of "national names" such as national leisure tourism agriculture demonstration counties and beautiful leisure tourism villages in China ranks first in the country [13]. How to lead from quantity to quality is the key issue of Jiangsu leisure agriculture development in the new period, and it is also the concern of the government. It is also an urgent problem for many leisure agricultural enterprises to move from "excellent" to "excellent" [14]. For this reason, the objects selected by our investigation are "National Star-rated Demonstration Enterprises of Leisure Agriculture and Rural Tourism" and the enterprises selected as "Theme Creative Agricultural Park of Jiangsu Province".

3.1. Basic Information. In order to make the sample representative in the region, taking into account the regional economic and social development level and leisure agriculture development level in Jiangsu Province, 13 enterprises in 8 districts and counties in 3 cities in southern Jiangsu, 9 enterprises in 8 districts and counties in 2 cities in central Jiangsu and 9 enterprises in 4 districts in 2 cities in northern Jiangsu were selected, with a total of 31 enterprises as the objects (see Table 1). In order to get the real first-hand information, we adopted the field survey method.

Table 1: List of distribution of research enterprises.

Region (city)		Number of the enterprise	Distribution area
Southern Jiangsu area	Nanjing	Six	Liuhe district, Gaochun district, Jiangning district and Pukou district
	Changzhou	Three	Wujin district, liyang city
	Suzhou	Four	Xiangcheng district and Wuzhong district
Central Jiangsu region	Yangzhou	Four	Yizheng city, Jiangdu district, Guangling district and Hanjiang district
	Taizhou	Five	Xinghua city, Jiangyan city, Taixing, Jingjiang
Subei region	Xuzhou	Five	Tongshan district, Jiawang district
	Yancheng	Four	Dafeng city and Dongtai city

4. Questionnaire Content and Results

4.1. Questionnaire Content. We believe that the transition from "good" to "better" must be the result of multiple factors of the system. Therefore, the investigation content combined with the research objectives is based on Professor Cooke P.'s theory of regional innovation system. It mainly includes: (1) The basic information of the enterprise: the name, scale, agricultural structure and organizational form of the enterprise; (2) Main contents of non-technical innovation of enterprises: business model and income sources, corporate culture, marketing, corporate management, corporate services, etc. (3) The main sources of non-technical innovation of enterprises: the setting of internal innovation departments, the institutions and reasons for external innovation, etc. (4) The internal and external support for non-technological innovation of enterprises: internal system, external organizational support, external system support, etc.

4.2. Result Analysis. According to the survey results, most excellent leisure agricultural enterprises pay more attention to the comprehensive utilization and development of agriculture, accounting for 54.84%, followed by planting-based development accounting for 41.94%, and animal husbandry accounting for only 3.22%. Further understand that livestock breeding enterprises have strict production standards, so that germs are brought from people to animals, so few people actively participate in leisure function development; In terms of enterprise scale, leisure agricultural enterprises are mainly small and medium-sized enterprises, among which medium-sized enterprises account for 57.89%, small enterprises account for 36.84% and micro enterprises account for 5.27%. According to the industry situation of leisure agricultural enterprises before engaging in leisure agriculture, the highest proportion of the first industry is 48.71%, the third industry accounts for 34.84%, and the second industry accounts for only 16.45%. It can be seen that most people engaged in leisure agricultural industry extend the industrial chain from the practitioners of the first industry or from the practitioners of the third industry, which is in line with the basic characteristics of the integration of leisure agricultural industries.

The results show that 87.1% of enterprises have a clear business model, and they are asking, "What are the main profitable products of your enterprise?" The number one is "characteristic agricultural products", accounting for 83.87%, followed by "farming experience", 70.97% and "catering", 45.16%. This result also confirms the importance of business model innovation to leisure agricultural enterprises. In "What aspects of non-technological innovation do you think this enterprise is in the leading position of similar enterprises in this region?" Among the problems, it is generally believed that they can be in the leading position in the region, mainly due to "project innovation", which accounts for 84.21%, followed by "service innovation", which accounts for 52.63%, and the third place is "marketing innovation", which accounts for 42.11%. It shows that these enterprises' emphasis on the above three items has brought them greater competitiveness, and further interviews show that Therefore, it is further confirmed that the competitiveness of "excellent" leisure agricultural enterprises largely comes from the emphasis on non-technological innovation. And from "What do you think is not innovative enough in this enterprise?" The results of (multiple choices) show that "marketing innovation" ranks first with 73.68% and management innovation ranks second with 57.89%. All belong to the category of non-technological innovation, which also shows that leisure agricultural enterprises from "excellent" to "excellent" have a strong expectation for non-technological innovation.

According to the survey, the non-technical innovation sources of leisure agricultural enterprises come from the enterprises themselves, accounting for 64.54%, and the external one account for 35.46%. This situation is further illustrated by the subsequent setting of non-technical innovation departments in leisure agricultural enterprises, among which, "Does the enterprise have non-technical innovation departments or personnel?" Among them, innovative departments account for the majority, but the proportion of part-time jobs is as high as 67.74%. This result is also in line with the fact that leisure agricultural enterprises do not set up non-technological innovation departments and personnel separately considering the personnel cost. It also shows that attaching importance to non-technological innovation is the consensus of Jiangsu's "excellent" leisure agricultural enterprises. In the problem of "need to carry out non-technical innovation with the help of external resources", non-technical innovations such as marketing innovation 83.33%, project innovation 70%, management innovation and service innovation both accounting for 56.67%, and organizational innovation 53.33%. Asked, "Does your company want to carry out non-technical innovation with external support?" As high as 96.77% are eager to get support, and in the follow-up "What do you

want to do for the enterprise if you need external resources", marketing innovation still ranks first, accounting for 83.33%, and management innovation ranks second with 56.67%.

"Is there a system document specifically encouraging non-technological innovation in this enterprise?" 41.94% think there is but not specific, and 35.48% think there is no special document. It can be seen that enterprises know the importance of non-technical innovation, but it is difficult to have a good method and strategy to implement it when encountering actual situations. "Does the local government have a system to support non-technological innovation of enterprises?" The problem of "yes, but I do not know how to operate" accounts for 58.71% of the total, which also shows that although the local government has a lot of support in non-technological innovation system, there is still a disconnect in the operation at the enterprise level. When asked, "If the local government has the support to support the non-technological innovation of enterprises, what do you want?" The order is financial support from the government, special loan support, establishment of a perfect multi-level intermediary service system or institution, establishment of local laws and regulations conducive to the development of enterprises, and improvement of financial service system to promote the non-technological innovation of enterprises. What about external institutions that want to rely on and assist the non-technological innovation of enterprises? In the first place, scientific research institutes account for 86.67%, followed by colleges and universities with 53.33% and social enterprises with 50%. Through further interviews, we know that the expectation of scientific research institutes is more guidance for the application of new agricultural technologies, and the expectation of colleges and universities is more demand for leisure agricultural talents besides guidance for the application of new agricultural technologies, while social enterprises are mainly in market channel cooperation and creative design. The government should increase the capital and technological investment in the development and industrialization of leisure agricultural resources, further improve the construction of relevant infrastructure, and formulate corresponding preferential policies to support from the financial and tax policies, so as to provide good policy environment conditions for the development and industrialization of leisure agricultural resources. At the same time, the government should formulate relevant unified institutional norms, improve the corresponding legal and regulatory system, strengthen norms, correctly guide, and provide a solid institutional guarantee for its development. In addition, the government should also increase investment in the training of relevant professional talents, provide corresponding training, promote the improvement of professional skills and management ability of leisure agricultural operators, and provide talent guarantee for the development of leisure agricultural resources and industrialization.

From the above results, it can be seen that a large part of the reasons for the excellence of leisure agriculture enterprises in Jiangsu are due to the emphasis on non-technological innovation. However, it is also found that the transmission of non-technological innovation system from top to bottom is still not smooth, especially at the municipal level, and the implementation of provincial leisure agriculture non-technological system is still lacking. At the same time, the survey results also show that enterprises have a strong expectation to get support from non-technological innovation and move towards excellence. Therefore, how to effectively construct the non-technical innovation system of provincial leisure agriculture has become the necessity to promote the high-quality development of Jiangsu leisure agriculture.

4.3. Discussion. We believe that the non-technical innovation system of leisure agriculture is basically consistent with other agricultural innovation systems, that is, the participating entities are innovation networks formed under various innovation relationships through geographical proximity and the aggregation of innovation elements, so as to improve innovation ability and competitiveness and promote regional agricultural economic development [15].

The innovation of agriculture is different from the innovation of other industries. It needs to consider many factors, such as natural environment, social culture, degree of economic development, level of science and technology, etc. Therefore, the agricultural innovation system constructed under different background conditions has different characteristics [16]. Leisure agriculture industry has obvious regional heterogeneity, so the non-technical innovation system of leisure agriculture must be built under the theoretical framework of regional innovation system [17]. The planning and design of leisure agriculture should be fully integrated with the local culture. The development of leisure farms should pay attention to the excavation of the connotation of agricultural culture and folk culture, and use culture to support the tourism context. "The more local, the more world". In the planning and design of leisure agriculture, the weight of cultural connotation in the farm is directly proportional to the attraction of the farm. The theme of leisure agriculture must be closely connected with regional culture. Based on the research results of the World Bank on agricultural innovation system, this paper tries to build a non-technical innovation system of Jiangsu leisure agriculture, which consists of two subsystems: innovation providing system and intermediary auxiliary system, plus regional leisure agricultural enterprise clusters, in which government departments, scientific research institutions, universities, leisure agricultural enterprises and intermediary social organizations are the main participants of the innovation system (see Figure 1). The participants in the non-technological innovation network of leisure agriculture are not isolated, but interact with other participants-farmers, government departments, scientific research institutions, universities, leisure agricultural enterprises, intermediary social organizations and other socio-economic environments. In other words, leisure agriculture non-technological innovation network is an organizational phenomenon affected by individual and collective behavior, innovation ability and favorable conditions. Interaction, coordination and collective action are based on the ability of all the above-

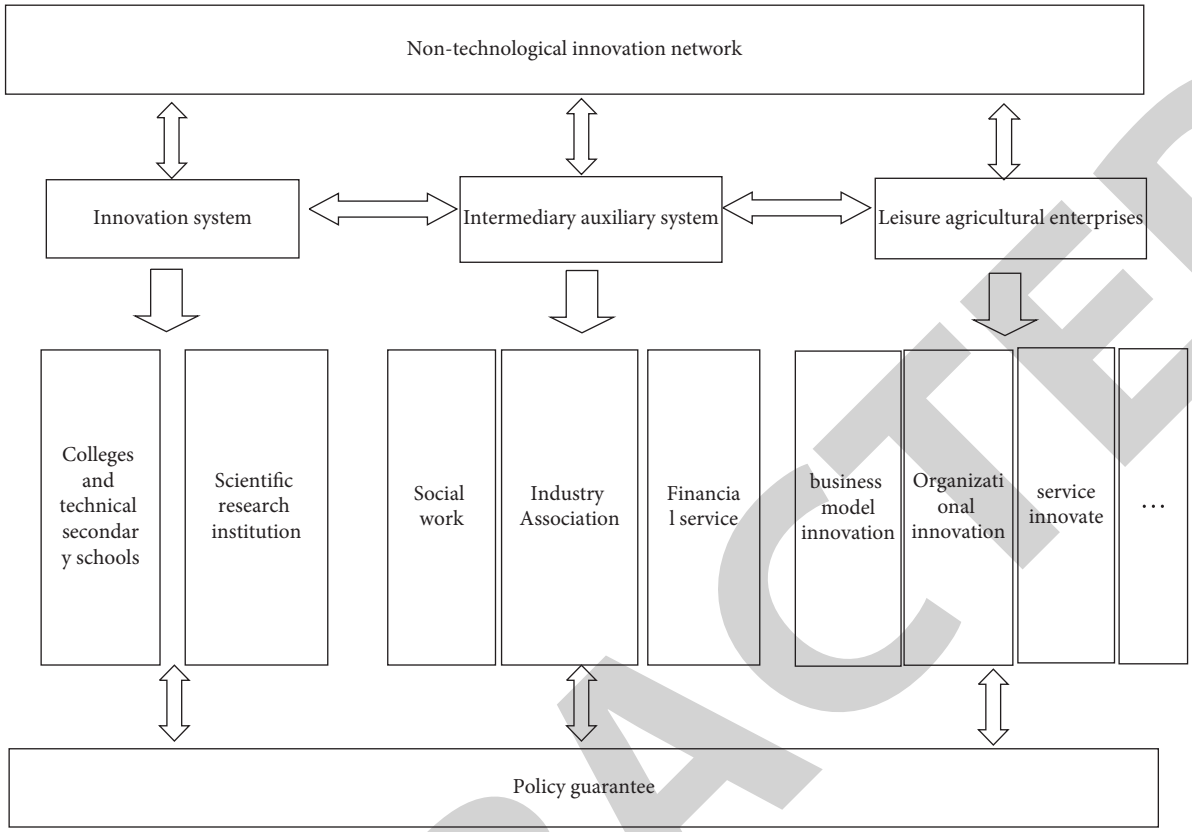

Figure 1: Non-technological innovation system of leisure agriculture.

mentioned participants to identify innovation opportunities, assess the challenges involved, and obtain the social, human and capital resources needed to innovate, learn and share information.

The core of enterprise development is innovation. The characteristics of leisure agricultural enterprises determine that non-technical innovation is of greater significance to the development of enterprises. Among them, non-technical innovation mainly includes business model innovation, value chain innovation, management model innovation, organizational culture innovation and system and mechanism innovation. It is worth pointing out that the micro-evolution of enterprises in non-technical innovation of leisure agriculture will affect the macro-evolution of industry through the interaction between enterprises, that is to say, leisure agriculture enterprises, like other enterprises, have co-evolution of enterprises and industries to form three levels, namely, micro-level enterprises, intermediate-level enterprises' interaction and macro-level industries. It should be said that the intermediate level is only an industrial phenomenon (see Figure 2). Therefore, our countermeasures and suggestions for Jiangsu leisure agriculture in the new period are mainly carried out from the micro and macro perspectives by combining the results of previous field investigation [18].

The gap of leisure agriculture development in southern Jiangsu, central Jiangsu and northern Jiangsu is obvious, and each prefecture-level city is not the same, so the transmission of non-technological innovation system should be different in different places [19]. From the provincial level of policy transmission, on the one hand, it is necessary to ensure the smoothness of the vertical dimension and form a "top-down" policy decomposition, transmission and feedback; On the other hand, because the development of leisure agriculture involves many departments besides agriculture, such as tourism, industry and commerce, transportation, etc., there should be corresponding interaction and coordination mechanisms in the horizontal dimension [20]. From the previous analysis, it can be seen that there are plenty of non-technical innovation system supply at both the national and provincial levels, but it becomes a "blocking point" at the municipal level of the executive level [21]. Therefore, opening up the executive level of the city and below becomes the key. Therefore, it is suggested that the municipal governments in Jiangsu should correctly judge their own endowments and existing strengths and weaknesses according to the overall goal requirements of the province for the high-quality development of leisure agriculture, and determine the realization path and corresponding policy tools of the prefecture-level cities and below, instead of simply transmitting documents [22]. At the same time, it is suggested that prefecture-level cities with conditions can try to incorporate the non-technical innovation performance of leisure agriculture into the cadre evaluation index, so that "leading geese to fly" can drive the high-quality development of local leisure agriculture [23]. As the epidemic enters the normal prevention and control, the demand for suburban leisure tourism, self-driving rural

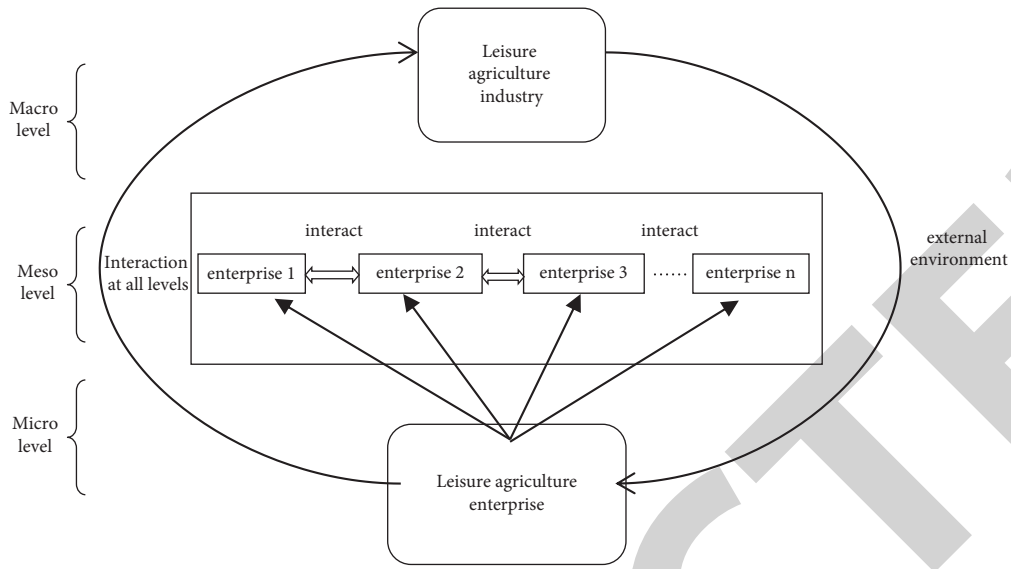

Figure 2: Co-evolution of enterprises and industries in non-technological innovation of leisure agriculture.

tourism and quality vacation tourism is stronger, and leisure agriculture and rural tourism have become the main battlefield of current consumption. The epidemic has brought many difficulties to leisure agriculture, but it has also provided new opportunities for promoting reform and development.

On the one hand, according to the previous investigation and analysis, it can be seen that leisure agricultural enterprises have a strong expectation to jointly carry out non-technological innovation with universities and scientific research institutions. Therefore, the cooperation among leisure agricultural enterprises, universities, technical secondary schools and scientific research institutions in the region should be promoted at the provincial and municipal levels at the same time. Learning from the practices of developed countries, an innovative strategic alliance should be established, and the self-adaptability, self-organization and high synergy of the innovation alliance should be used to jointly research and develop the key issues of non-technological innovation, making it an ideal way to improve the non-technological innovation capability of leisure agricultural enterprises [24]. On the other hand, because leisure agricultural enterprises are generally located in rural areas, being far away from urban geographical features is the ecological environment advantage of leisure agricultural enterprises, but it also brings difficulties in attracting and retaining talents for leisure agricultural enterprises [24]. Therefore, it is suggested that local governments should seize the policy opportunity of "integration of industry and education" in the National Implementation Plan of Integration of Industry and Education, strengthen cooperation with Industry-University-Research, promote the organic connection between regional education chain, talent chain and industrial chain, and innovation chain, and find their own entry point from policies such as "20 vocational education articles" and "action plan for improving quality and excellence" in terms of talent supply, and explore the development of "modern apprenticeship" and "apprenticeship" with vocational colleges [25].

The intermediary subsystem mainly includes social services, trade associations and financial services. In terms of social services, there is still a certain gap between the existing leisure agricultural enterprises and industrial enterprises in obtaining social services. Therefore, it is suggested that the number and scale of intermediary service providers should be expanded to meet the requirements of high-quality development of leisure agriculture in the new era [26]. The trade associations need to pay attention to the integration function of trade associations in the innovation of enterprises in the region, and fully realize that trade associations are an important way for regional enterprises to exchange knowledge and stimulate mutual learning and innovation. However, it is known from the survey that for various reasons, there are not all leisure agriculture trade associations in all prefecture-level cities in Jiangsu, which also makes it difficult for the prefecture-level cities that have not been established to pass on "innovative knowledge" to enterprises. From the perspective of Changzhou, the first city in Jiangsu to establish a local leisure agriculture association, whether for individual leisure agriculture enterprises or the development of local leisure agriculture industry, In terms of financial services, because leisure agricultural enterprises have the double risks of agricultural natural risks and market changes, animals and plants are difficult to finance as collateral, so it is more difficult to finance compared with other enterprises. Fortunately, on May 17, 2021, the national level took specific financial support measures for the high-quality development of leisure agriculture. On July 29, 2021, Jiangsu Province also launched a special financial support policy for leisure agriculture, which was complementary to the national level, to help leisure agriculture solve the problem of "difficult and expensive financing" that has been plaguing the high-quality development of leisure agriculture.

Leisure agriculture belongs to a new type of business, which integrates the primary, secondary and tertiary industries. One of its important features is that it spans the focus of a single industry. The positioning drift has reached an interval from a single point. Facing this change from focus to interval, the essence is that leisure agricultural enterprises need to meet the product value needs of tourists at different levels. However, this change is the integration of a single industry in terms of industry, and many different value chains are composed in specific operations, and the value chains that are constantly spawned will inevitably impact and influence the business model of the old enterprises [27]. Coupled with the current "Black Swan Incident", such as the emergence of the new crown epidemic, leisure agricultural enterprises, as suppliers of products, should make a multi-dimensional change on the basis of the vertical creation of the original products. At the same time, under the promotion of "Yangtze River Delta Integration" strategy, the interaction between people and people in Jiangsu is intensifying, and the structure of the original customer market will change, which will bring more diverse consumption purposes. This determines that leisure agricultural enterprises must innovate their business models, enrich their product systems as soon as possible, and increase their product supply capacity to diverse people.

The integration of leisure agriculture determines that it is different from traditional agricultural enterprises, but it cannot be equated with agricultural processing enterprises and tourism enterprises. This remarkable feature determines that its internal enterprise organizational structure must be changed to meet the needs of the integration of the first, second and third industries. However, from the preliminary investigation, it is found that some leisure agricultural enterprises in Jiangsu have not fully realized this feature. The internal organizational structure of enterprises is either consistent with traditional production agriculture or focuses on the organizational structure of tourist attractions. Under the actual situation of multi-dimensional integration boundary of leisure agricultural industry, some cases can be said to embed the service value module of traditional agriculture. Therefore, combined with the characteristics of industrial integration of leisure agricultural enterprises, leisure agricultural enterprises should carry out the mixed integration of organizational structure to improve their own operational efficiency.

Leisure agricultural enterprises can be invincible only through continuous self-transcendence, which is the main starting point from service ability and experience enhancement in terms of non-technical innovation. Fully aware that, unlike other industrial enterprises, which are close to the city, leisure agricultural enterprises must have obvious disadvantages in obtaining information and interactive experience with consumers. Therefore, the competition among leisure agricultural enterprises is mostly reflected in whether the "service experience" has been formed, because any transaction must have gone through mutual understanding and understanding, thus forming trust and loyalty, and finally it is possible to get a higher product premium. A good leisure agriculture operation system is a complex system, which involves the government, residents, educational institutions, non-governmental organizations and other aspects. The creation of immersive experience in leisure agriculture is based on this. It integrates landscape, humanities, science and technology, theme and other factors in an orderly manner, which not only realizes the coordinated operation of points, lines and areas, but also creates a sustainable multi-party circulation system, so that participants can feel a harmonious and beautiful whole from the atmosphere, details, and environment. Specifically, leisure agricultural enterprises can enhance their "service interaction" and competitiveness from two aspects. First, leisure agricultural enterprises fully realize their geographical disadvantages, pay attention to market information collection, establish more detailed customer files than ordinary enterprises, and help enterprises to continuously improve their "enterprise IQ"; The second is to establish a link channel with the most valuable customers and the most potential customers. Specifically, we can conduct timely information feedback with these two types of customers through the "offline + online" channel.

5. Conclusion

With the rapid development of China's economy and society, leisure agriculture has changed from the "budding stage" of "eating farm meals, living in farmhouses, doing farm work, seeing farm scenery and enjoying farmhouses" to the "creative stage", and from the "quantity scale" to the "high-quality" stage. However, as a new industrial format, its industrial integration makes the operational level more difficult than the single primary, secondary or tertiary production, so how to develop it according to its characteristics? Based on industrial economics, technological innovation economics and evolutionary economics, combined with field investigations in different areas of Jiangsu Province, this paper explores the law of leisure agriculture development and innovation, verifies the theoretical judgment that non-technological innovation is the rational choice of leisure agriculture development with actual investigations, and builds Jiangsu leisure agriculture non-technological innovation system with reference to the theoretical research results of agricultural innovation system, and puts forward countermeasures and suggestions. This exploration is a concrete application of non-technological innovation research in the field of leisure agriculture, and a beneficial exploration of the effective path of high-quality development of leisure agriculture.

Data Availability

The figures and tables used to support the findings of this study are included in the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Retraction

Retracted: Analysis and Application of the Business English Translation Query and Decision Model with Big Data Corpus

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Gong, "Analysis and Application of the Business English Translation Query and Decision Model with Big Data Corpus," *Security and Communication Networks*, vol. 2022, Article ID 2714079, 10 pages, 2022.

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Research Article

Analysis and Application of the Business English Translation Query and Decision Model with Big Data Corpus

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This paper aims to build an English translation query and decision support model using big data corpus and applies it to business English translation. Firstly, the existing convolutional network is improved by using depth-separable convolution, and the input statements are mapped to the depth feature space. Secondly, the attentional mechanism is used to enhance the expressive ability of input sentences in deep feature space. Then, considering the sequential relationship, use long short-term memory (LSTM) neural network as a decoder block to generate the corresponding translation of the input sentence. Finally, nonparametric metric learning module is used to improve the model in an end-to-end way. Wide range of experiments on the multiple corpora have shown the proposed model has better real-time performance while maintaining high precision in translation and query, and it has a certain practical application value.

1. Introduction

The new technologies are developing rapidly, such as big data and artificial intelligence (AI), machine translation is becoming more intelligent and humanized, and the results of machine translation are gradually approaching the human mind manner. The error rate of machine translation has gradually decreased, and the accuracy of translation has made a breakthrough [1] by using big data, AI, natural language processing, and other related technologies. Microsoft, Baidu, and Google have launched AI-based intelligent translation systems. However, the machine translation based on AI technology has made great progress, and there are still many shortcomings in terms of deep semantic structure, different stylistic styles, language styles, and discourse levels, which are hard to satisfy the needs of practical application [2]. Therefore, we need to build a corpus with big data. And the constructed corpus is used to train the translation model, which makes machines increasingly intelligent.

The corpus-based method is to describe the same information or topic in two or more languages and establish the connection between different language information through manual or computer. Corpus is divided into parallel corpus and comparable corpus [3]. Corpus has mostly obtained information resources through the Internet and large literature collection and analyzed and constructed automatically. The corresponding relationship between different languages on the same information or topic in the corpus is aligned, which contains abundant translation materials and knowledge. For parallel corpus, the query translation process will produce different results, through the statistical probability of the word in both source and target languages in word frequency. It can select the best translation results by using statistical analysis. The main methods include cross-language latent semantic indexing, generalized vector space model, and correlation feedback method. The above method aims to achieve fast indexing and eliminate ambiguity between words. Different from dictionaries, this kind of method has a large amount of semantic space. Corpus exists in chapters, abstracts, and paragraphs, while parallel corpus has a powerful computing function, providing a good platform for translation queries in cross-language information retrieval [4].

Query translation is the language used to directly translate users' query requirements into target documents.

This approach is currently the most widely used translation strategy and can be realized by using a single language retrieval system directly [5]. The advantage of this approach is simplicity and flexibility, and it only needs a small resource consumption, but there will be polysemy in the process of user query translation. To solve the ambiguity problem, the statement package is added first, and the query expression is extended. In addition, the system interaction function is used to achieve the query requirements. Secondly, the recognition and matching of the input statements are completed with the theme meaning of the file, and the natural language processing mode is adopted. Finally, the feedback results are re-translated. The following techniques are generally used to implement questioning translation: dictionary-based approach, corpus-based approach, dictionary-corpus hybrid approach, and questioning weighting method.

The core modules of the translation and decision system mainly include corpus construction and decision module [6]. Among them, the corpus is the carrier of knowledge representation and storage. At present, the corpus mainly expresses the semantic relationship between the sentence to be queried and empirical knowledge by using triples [7]. The query and decision-making task of the corpus is to identify the natural language which included entities, entity relationships, and entity types. The answers are searched based on the language matching manner [8]. Recently, common translation query and decision-making systems mainly include semantic parsing methods and information retrieval. The semantic parsing method directly identifies entities, entity relationships, and entity combinations from questions by compiling rule bases, auxiliary dictionaries, artificial reasoning, machine learning, and deep learning. For example, Cheng et al. [9] have used the sequence labeling model to identify the entities in the problem, used the sequence-to-sequence model to predict the relational sequence in the problem, and used the answer verification mechanism and the circular training method to improve the performance of the model. Moradshahi et al. [10] have proposed an automatic machine translation generator based on large-scale dialogue data sets to solve the problem that the multi-task dialogue system is not robust. The input sentences are analyzed according to the similarity value between the corpus and the sentences.

The method based on information retrieval firstly identifies the candidate entity set in the question by other means, such as entity identification technology and entity dictionary, and then, according to the predefined logical form, all the one-hop or multi-hop relationships of candidate entities in the knowledge base are queried from the corpus, thus obtaining the candidate query path set. Finally, the candidate query path with the highest matching degree is obtained by calculating the similarity value among the query path and the problem, and the answer is queried in the knowledge base [11]. For example, Zhang et al. [12] have presented a method to enhance relationship matching, bi-layer bidirectional long short-term memory network (BiLSTM) is first used to match candidate relationships at multiple levels, and then it uses relationship matching to reorder entity link results. Li et al. [13] have simplified the matching mode of the existing question answering system by using a knowledge map, by convolutional neural network for identifying the semantic features of questions, by the matching degree of answers and questions for determining the results. Li et al. [14] proposed a causal relationship extraction model for a knowledge convolution neural network. The causal relationship in the input sentence has captured by fusing human prior knowledge, and the attribute mapping has performed based on the BiLSTM of the attention mechanism. Finally, the answer was selected from the knowledge base based on the results of the first two steps.

The number and variety of information resources available on the Internet are becoming increasingly rich, and the language is uneven and diverse. The number of Internet users is also growing, and their languages are diverse. Due to the diversity of language resources on the Web and the differences in language mastery among Web users, language barriers arise when retrieving information via the Web, causing inconvenience to non-English speaking users. Thus, this has important implications for the study of English-Chinese cross-language information retrieval design.

In conclusion, although all the above models have achieved good translation results, most of them are only verified on short sentences, and their effects on long sentences and complex sentences are not good. Secondly, the overall performance of business, medical, and other professional translation is poor. The main reason is that the contextual semantic information is not fully considered. In addition, professional databases such as medical and business English contain limited words. Therefore, this paper will build a corpus-based English translation query and decision system, which is based on big data, and apply it to business English translation.

2. Model Design

Figure 1 shows the analysis and application of the business English translation query and decision system supported by the big data corpus. (a) A feature extraction module extracts the depth features of input text at character and word level by using a convolutional neural network; (b) attention mechanism considers the context sequence relationship of the input text, using the attention mechanism to strengthen the expressive ability of features in-depth space; (c) a decoding module decodes the output features of the attention mechanism to generate a translation corresponding to the input text; (d) measurement learning module: the cosine similarity between the translation generated by the decoder and the corresponding real tag is measured to realize the end-to-end optimization of the model.

2.1. Textual Vectorization. Text vectorization is the first step of the translation query system. Common text vectorization includes one-hot representation, TF-IDF (term frequency-inverse document frequency) representation, and Word2-Vec representation.

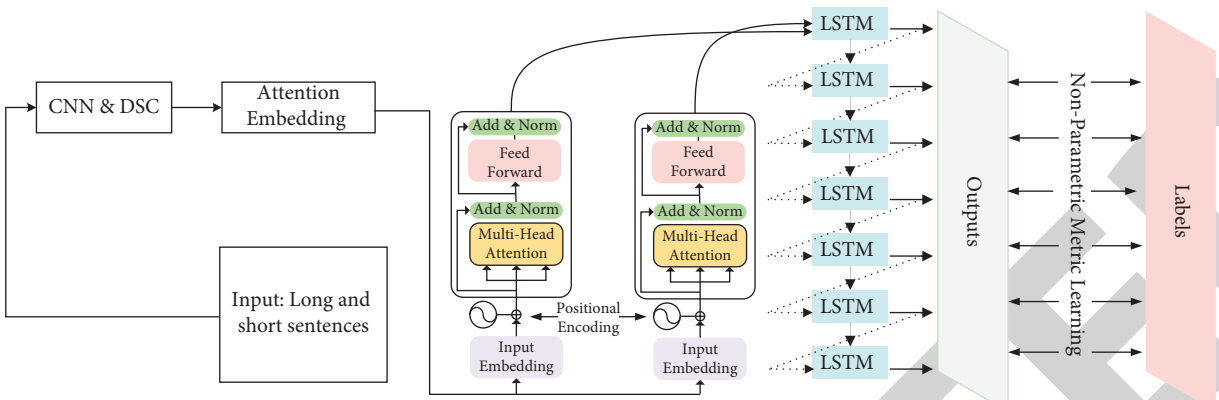

Figure 1: Model architecture diagram.

One-hot representation is the earliest and intuitive word vector generation method with a simple and direct structure, and the generated vector representation reflects the information of word frequency. This mapping method firstly summarizes all the words in the corpus to obtain N-words and generates an N-dimensional vector for each document in the corpus, in which each dimension reflects how many specific words exist in the document. However, this textual vectorization only considers word frequency and causes the vector lengths of long sentences and short sentences to be inconsistent.

TF-IDF represents the mapping relationship that takes into account the inverse document frequency in the document vocabulary. When using the TF-IDF method for text vectorization, the word frequency is normalized first, even though the frequency of word occurrence rather than the number represents the word frequency. In addition, the existing improved TF-IDF text vectorization method also considers the inverse document frequency index of each word and uses this index as a measure of word rarity to better characterize the document generation vector. However, the common disadvantage of the above two models is that the vector length is very large. For a corpus with a large vocabulary, the mapping vector length of each document is long, which means that the resulting matrix is very sparse and complicated to calculate.

In natural language processing (NLP), Word2Vec representation is the most classical pertaining models. Word2Vec has the advantages of simplicity, speed, and versatility, but it is limited by the corpus, and the word representation generated is static, unable to solve the problem of polysemy, and cannot reflect the multi-layer characteristics of the word, including grammar and semantics.

BERT model is a new vectorized representation of text processing proposed in recent years. Compared with word embedding methods represented by Word2Vec, the BERT model is more adaptive and can solve the problem of polysemy. In addition, BERT based on transformer, using transformer's bidirectional encoder structure, can reflect the multi-layer characteristics of words. This paper uses the BERT-based model, which has 12 transformer encoders, each transformer encoder has 12 heads, and the hidden layers have a size of 768.

2.2. Feature Extraction. Convolutional neural network (CNN) is a feed-forward neural network that has been widely used in recent years in text classification, computer vision, and other fields [15]. The translation query and decision system constructed in this paper firstly use a convolution network as a feature extractor to realize the feature extraction of input text. CNN is mainly divided into convolutional layer, pooling layer, and fully connected layer. Here, inspired by bidirectional short memory neural networks, we take full account of the fact that the model will analyse two sentences in parallel manner. Therefore, we use the parallel convolutional neural network structure here. Compared with traditional convolution, it has a better sensibility field due to the consideration of parallel spatial sequences. However, as the depth of the network increases, the time cost of the model will inevitably increase. This paper comprehensively considers the real-time requirements of the translation system. Here, we adopt parallel convolution to alleviate the time cost problem. Thus, the parallel CNN structure is adopted. The framework of the parallel CNN is presented in Figure 2.

In Figure 2, each layer of the network is responsible for realizing different functions, among which the convolution layer is responsible for completing most of the computation work in the convolution network, such as local feature extraction, thus making CNN generate a local receptive field. The pool layer is usually located between two convolution layers. By down-sampling, the number of parameters and network calculations is gradually reduced, and the spatial dimension is reduced. The typical pooling method is to calculate the maximum value of each local block in the feature matrix, and then the adjacent pooling units are translated to get the feature matrix of the lower input. The specific operation is shown in formula.

$$\begin{cases} c_i = \sigma(w\mathbf{X} + b), \\ \mathbf{X} = [x_1, x_2, \ldots, x_{i+1}, x_{i+\kappa}], \end{cases} \tag{1}$$

where c_i is the result of the convolution calculation, X is the input matrix, σ indicates the activation function,

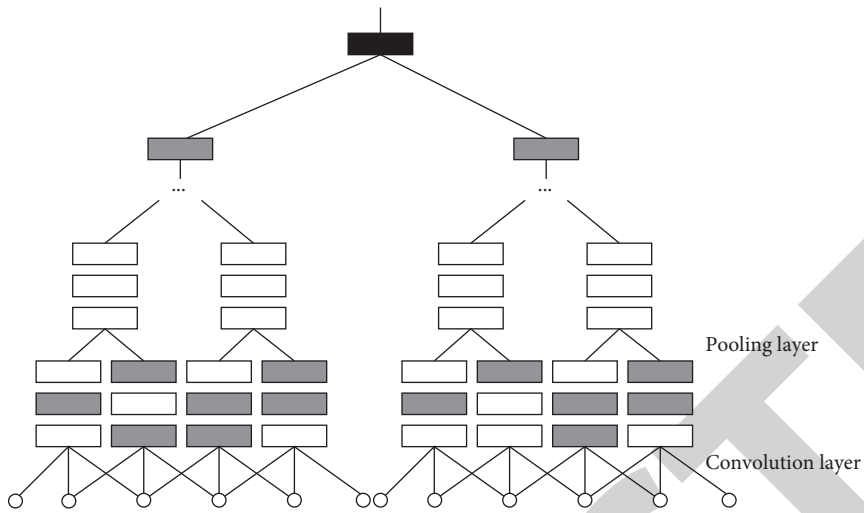

Figure 2: Parallel CNN structure.

PReLU (parametric corrected linear unit) activation function is used here, w represents the parameter of each convolutional kernel, and κ indicates the size of the convolutional kernel.

Here, considering the high real-time requirement of the actual translation and query system depthwise convolution (DW) [16] and pointwise convolution (PC) [17] are combined to form depthwise separable convolution so as to reduce the computational burden of the model and further reduce the time cost of the model by reducing the number of parameters. In particular, depth-separable convolution consists of depthwise convolution (DW) and pointwise convolution (PC). By decomposing the standard convolution process into several equivalent deep convolutions and point-by-point coupon products, the computational complexity of the model is reduced. The processing of the deep-separable convolutional neural network is shown in Figure 3.

In the traditional convolution operation, the convolution kernel of the size $L \times L$ is used in the convolution calculation phase, and the output channel size is M. The deep convolution DW-operated processing is shown in Figure 3. M convolution kernels of the size $L \times L$ are used for each convolution calculation, and the output is usually 1. In every calculation of the pointwise convolution, M convolution kernels of the size are used for convolution filtering. Deep convolution DW and PC can be spliced into a standard convolution with convolution kernel size $L \times L$, and the channel is also set to M. Among them, the parameters involved in the calculation of the standard convolution CNN are shown in formula.

$$\Delta_{\mathrm{CNN}} = L \times L \times M \times N. \tag{2}$$

The number of parameters involved in the depth-separable convolution calculation of the combination of DW and PC is shown in

$$\Delta_{DW,PC} = L \times L \times 1 \times M + 1 \times 1 \times M \times N, \tag{3}$$

$$R = \frac{\Delta_{DW,PC}}{\Delta_{CNN}} = \frac{L \times L \times 1 \times M + 1 \times 1 \times M \times N}{L \times L \times M \times N} = \frac{1}{L^2} + \frac{1}{N}. \tag{4}$$

It can be seen from formula (4) that when convolutional kernel $L \geq 2$, the number of parameters involved in the deeply separable convolution calculation is obviously less than that in the standard convolution calculation. Therefore, using the depth-separable convolution instead of the standard convolution can reduce the time cost in convolution calculation.

2.3. Attention Mechanism. Although depth-separable convolution can extract the deep features of the input text or sentence, it fails to fully consider the contextual semantic information between characters in the input sentence, resulting in poor fluency and incomplete semantic information of the translation results, especially in complex sentences or long sentences. Here, we take inspiration from transformer and use the encoder block and multi-focus module provided by transformer to effectively alleviate the problem of long sentences relying on long distance. The transformer block can be found in Figure 4.

To address the above problems, we introduce transformer encoder block with an attention mechanism, take the output feature map of depth-separable convolution as the input of the transformer coding block, using the attention mechanism provided by the coding block to establish the context dependency [18], and solve the problem that the existing models make insufficient use of deep semantic information. The transformer structure is shown in Figure 4.

In Figure 4, the left part illustrates the encoder block and the right part shows the decoder block. Multiple encoder block is used to form the encoder module. Similarly,

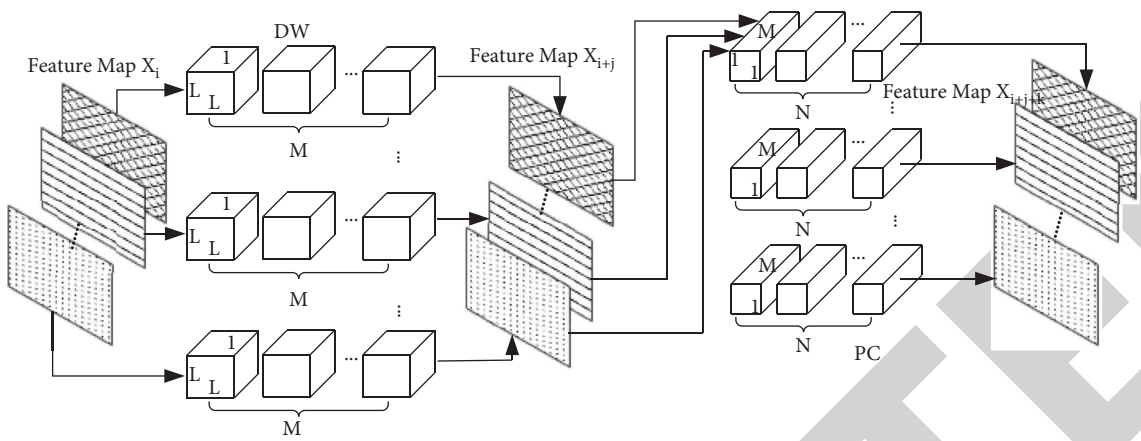

Figure 3: Structure of depth-separable convolution model.

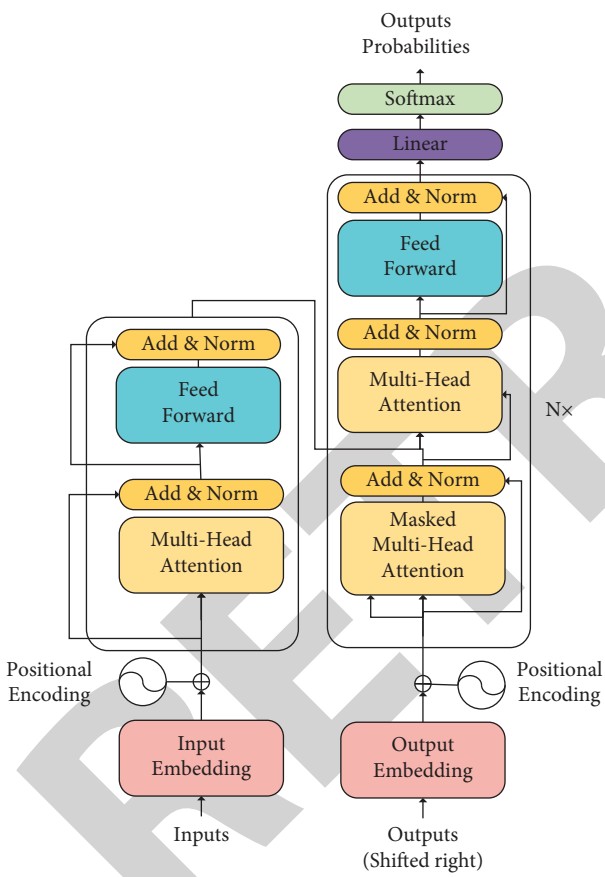

Figure 4: Transformer architecture.

multiple decoder block is used to form the decoder module. The task in Figure 4 will be taken as an example.

The input of the encoder is a natural language. Before the first encoder block is sent, the natural language needs to be digitized. The processing flow is shown in Figure 5. Firstly, word embedding and position embedding of each token are added bit by bit for each token after word segmentation, and the representation vector of each token in the statement is obtained and arranged line by line to form an input matrix X that can represent a sentence. Here, the word embedding of each token is obtained by the Word2Vec module; the position embedding of each token is shown by formula.

$$\begin{cases} PE_{(\text{pos},2i)} = \sin\left(\dfrac{\text{pos}}{10000^{2i/d_{\text{model}}}}\right), \\ PE_{(\text{pos},2i+1)} = \cos\left(\dfrac{\text{pos}}{10000^{2i/d_{\text{model}}}}\right), \end{cases} \tag{5}$$

where pos indicates the position of the token in the sentence, $2i$ represents the $2i$-th position in the position vector of the token, and the d_{model} represents the word vector dimension.

2.4. Decoder Module. The text has a strong temporal attribute, and the corresponding words in the translation also have sequence dependence [19]. Considering that the traditional template matching generation method only decodes short sentences, it does not have to deal with long-term dependencies. In addition, we adopt parallel convolution (as shown in Figure 2) in the feature coding stage, and feature decoding after the output of parallel convolution can be realized only by using one-way LSTM network. Since parallel convolution has been used in the encoding stage, i.e., a single convolution is used for feature encoding on each of the two channels, and the semantic information on the adjacent time series has been considered for the upper and lower channels. Therefore, the decoder module of this paper adopts the multi-layer LSTM as the basic structure. LSTM is a special recurrent neural network (RNN), and it is used to solve the gradient disappearance and gradient explosion in long sequence training. Specifically, compared with RNN, LSTM has better performance in long sequence dependence problem. The network structure of the LSTM unit is shown in Figure 6 and consists of an input gate, forgetting gate, output gate, and memory unit [20].

Assume that at time t, the output result of the model encoder is set 1024-dimensional vector x_t. In the previous step, the LSTM gating unit outputs the hidden layer result as $h_{t\text{-}1}$, and the memory unit of the current step is c_t. The activation function is used to weight the feature vectors, and the output result of the input gate is obtained as the input eigenvector of the LSTM unit. Similarly, the forgetting gate

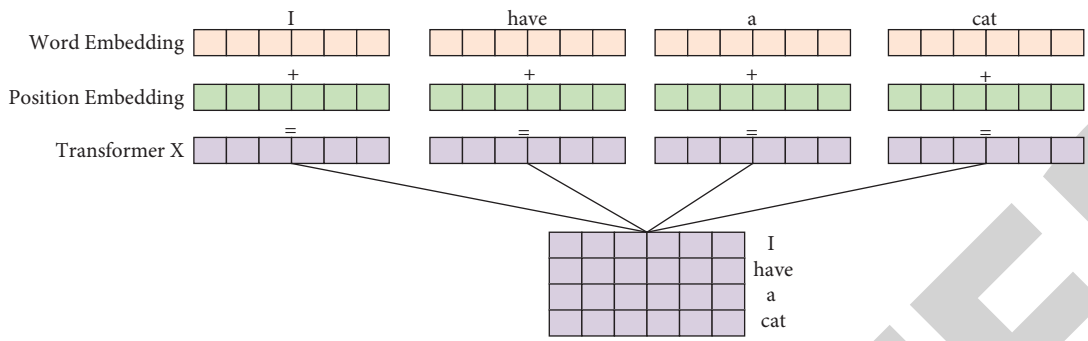

Figure 5: Schematic diagram of the word embedding.

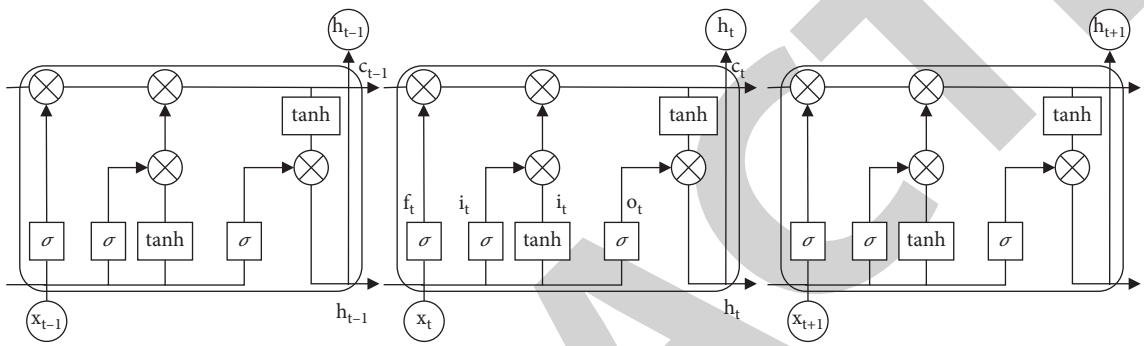

Figure 6: LSTM network structure.

feature f_t and the output feature o_t can be obtained, and the calculations are shown in

$$i_t = \sigma(W_{xi}x_t + W_{hi}h_{t-1} + b_i), \tag{6}$$

$$f_t = \sigma\left(W_{xf}x_t + W_{hf}h_{t-1} + b_f\right), \tag{7}$$

$$o_t = \sigma(W_{xo}x_t + W_{ho}h_{t-1} + b_o), \tag{8}$$

$$g_t = \phi\left(W_{xg}x_t + W_{hg}h_{t-1} + b_g\right), \tag{9}$$

$$c_t = f_t \otimes c_{t-1} + i_t \otimes g_t, \tag{10}$$

$$h_t = o_t \otimes \phi(c_t), \tag{11}$$

where σ represents the sigmoid activation function, ϕ is the tanh activation function, and $\otimes$ represents Hadamard product operation.

In the decoding process, the coded feature sequence after the attention mechanism is used as input for the decoder LSTM and then obtains the output result of the corresponding hidden layer $H = (h_1, h_2, h_3, \ldots, h_n)$. When the model decoder inputs the last feature vector, the hidden layer of LSTM network outputs the result, that is, the decoding result of the current input text sequence. LSTM decoder is shown in Algorithm 1.

2.5. Nonparametric Metric Learning Module. Considering the real-time requirement of translation system, the nonparametric metric learning module without any learning parameters is used to calculate similarity value. Here, cosine similarity calculation strategy is adopted to calculate the similarity value between the predicted translation result and the real label, and the model is optimized end to end according to the similarity value. Furthermore, to reduce the difference between model-generated translation and real translation results, parametric metric learning is adopted [21]. The model is optimized in an end-to-end approach using the translation generated of the model with the real translation.

In the metric learning module, the LSTM network is used to embed the real translated sentences into the sentence-vector space. Then, the cosine similarity value between the corresponding generated translation and the real translation embedded vector is calculated; finally, the similarity between them is judged according to the similarity value. The similarity calculation diagram is shown in Figure 7. When the angle is greater than 90, that is, the two vectors are orthogonal to each other, indicating that the sentences are not related to each other. The cosine similarity between two sentences is calculated as shown in formula.

$$L_{\text{sim}} = \frac{S_1 \cdot S_2}{\|S_1\|\|S_2\|} = \frac{\sum_{i=1}^{n} S_{1_i} S_{2_i}}{\sqrt{\sum_{i=1}^{n} \left(S_{1_i}\right)^2} \sqrt{\sum_{i=1}^{n} \left(S_{2_i}\right)^2}}, \tag{12}$$

where S_1 and S_2 represent the dot products of the two sentences.

3. Experimental Results

3.1. Construction of Big Data Corpus. The mainstream Corpus of Contemporary American English (COCA),

Input: Initialize weights W_{xi} and W_{hi}, encoder features
(1) Using formula (7) to compute the forgetting gate feature vector ft;
(2) Using formula (6) to compute the input gate eigenvector i_t;
(3) Using formula (9) and formula (10) to calculate the input modulation gate characteristic vector g_t, and update c_{t-1} to c_t;
(4) Using formula (8) to calculate the output gate characteristic vector o_t;
(5) Repeat steps (2) and (4) until all feature decoding is completed, and the input of the last decoding unit is the output result of the decoder.
Output Decoder Result

Algorithm 1: Translation Generation Module.

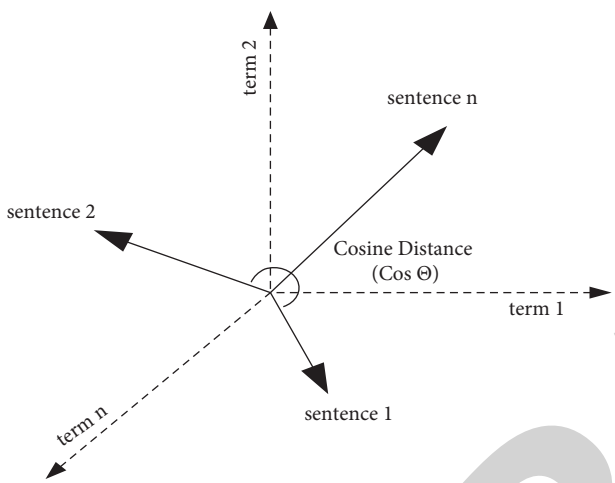

Figure 7: Cosine similarity between sentences.

Michigan Corpus of Academic Spoken English (MICASE), and British National Corpus (BNC) are used to construct the big data corpus in this paper, and duplicate words are removed, which consist of 3.8 million words. It contains business lecture, seminars, consultation meeting, business negotiations, etc. And a translation result of the Youdao is selected to construct a word label. In addition, we use the results of Youdao translation as additional labels. In the nonparametric metric learning phase, the model is optimized in an end-to-end approach with additional labels. According to the ratio of 7 : 3, all data are divided into the training set and testing set.

3.2. Experimental Environment. We implement the proposed approach using PyTorch, and extensive experiments are implemented on 256 GB CPU, NVIDIA A100 GPU with 40 GB memory. CUDA environment is adopted NVIDIA CUDA 11.3 and cuDNN V8.2.1 deep learning acceleration library, and *Python* version is 3.5.2. We set the weight decay of 0.0005, initial learning rate of 0.0001, and reduced by a factor 0.1 after every 0.0004.

Figure 8 shows the accuracy and loss curves for the training and testing phases of the proposed model. From the analysis of the accuracy and loss curves in the training and testing phases, it can be seen that when the model epoch is 35, the accuracy and loss curves in both the training and testing sets tend to stabilize, and then the curves change slightly, indicating that the model has converged. Therefore, the iteration epoch of all experiments in this paper is set as 35.

3.3. Evaluation Indicators. Accuracy, false-negative rate (FNR), false-positive rate (FPR), and F1-score are adopted as evaluation metrics in this paper, and all of them are shown in formula (13). Table 1 gives the confusion matrix of the classification. Generally, the higher the accuracy and F1-score, the lower the FPR and FNR, indicating the better the model performance. In addition, in order to avoid the unstable result of a single experiment, the average value of five experiments is used as the final evaluation result.

$$\begin{aligned} \text{Accuracy} &= \frac{TP + TN}{TP + TN + FP + FN}, \\ \text{FPR} &= \frac{FP}{TN + FP}, \\ \text{FNR} &= \frac{FN}{TN + FN}, \\ F1 - \text{score} &= \frac{2 \times \text{precision} \times \text{recall}}{\text{precision} + \text{recall}}. \end{aligned} \tag{13}$$

4. Results and Analysis

The comparison experiments are conducted on the same data set so as to validate the performance of our model. Here, the model provided in literature [22–25] is used as comparative approaches. And the above methods are represented as A, B, C, and D, respectively. The results are presented in Table 2.

It can be seen that the overall advantage of this model is more obvious compared with the current mainstream translation query model. Particularly, for the accuracy, compared with the two best performing models A and B in all comparison models, this model is improved by 0.81% (94.08%⟶94.85%) and 1.33% (93.60%⟶ 94.85%), respectively. On the FNR side, compared with the two best performing models A and B in all comparison models, in this paper, the model decreased by 6.53% (5.05%⟶4.72%) and 10.78% (5.29%⟶4.72%), respectively. On the FPR, compared with the two best performing models A and C in all comparison models, the proposed model decreases by 10.29% (4.86%→4.36%) and 13.32% (5.03%→4.36%)

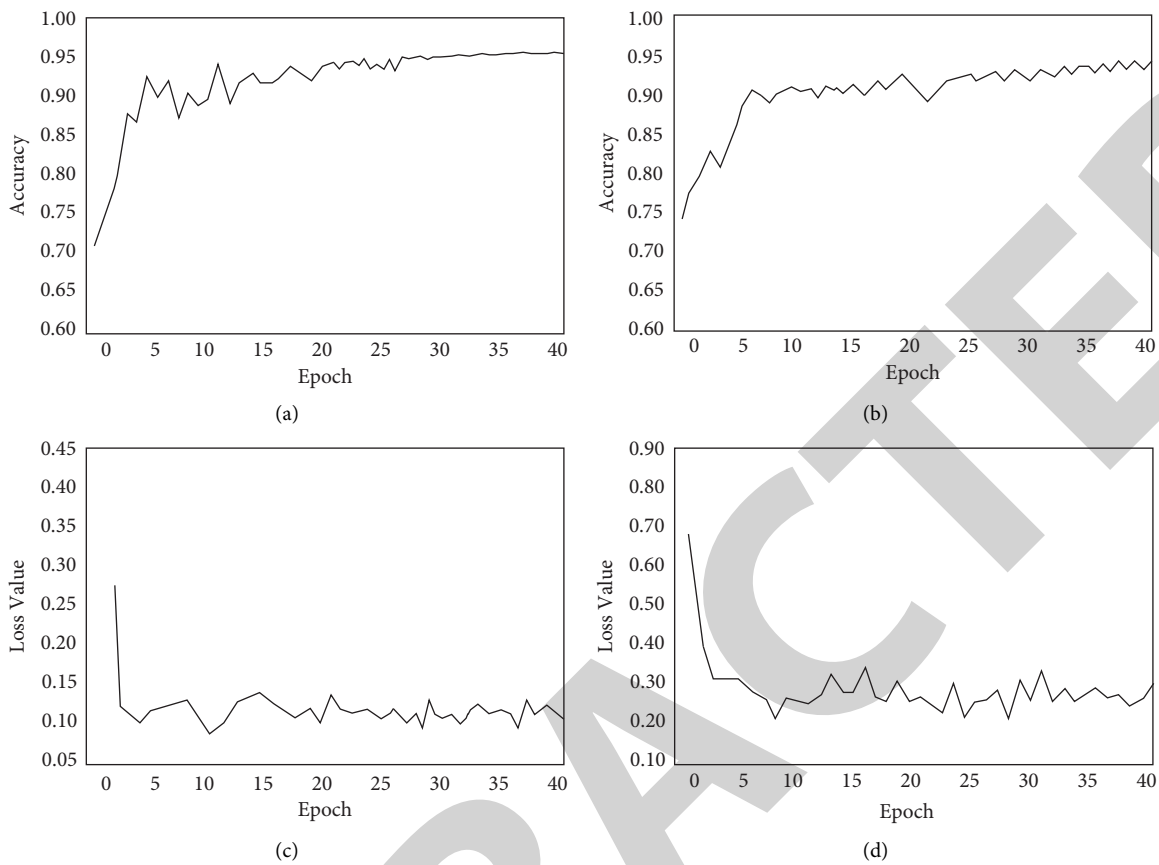

Figure 8: Accuracy and loss curves on training and validation sets. (a)Accuracy curves of the training set. (b) Verification of the accuracy curve of the set. (c) Training set loss curve. (d) Verify the set loss curve.

Table 1: Confusion matrix.

The actual class	Predict class	
	Positive	Negative
Positive	TP	FN
Negative	FP	TN

Table 2: Experimental results of different models (%).

Methods	Accuracy	FNR	FPR	F1
A	94.08	5.05	4.86	94.38
B	93.60	5.29	5.18	93.82
C	92.91	6.01	5.03	93.22
D	91.79	6.52	7.14	92.05
Ours	94.85	4.72	4.36	95.01

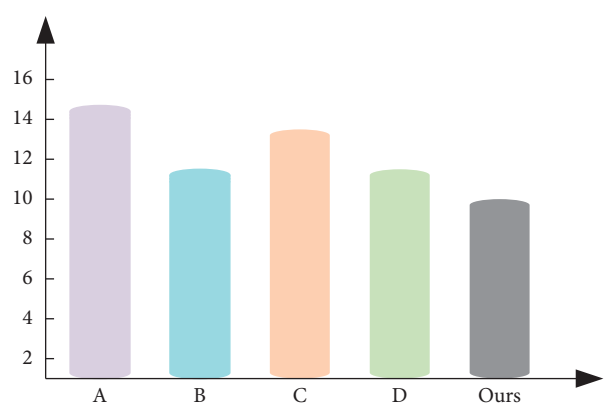

Figure 9: Real-time comparison results of different models.

respectively. On the F1 side, compared with the two best performing models A and B in all comparison models, this model is improved by 0.66% (94.38%⟶95.01%) and 12.68% (93.82%⟶95.01%), respectively. The experimental results above show that the overall advantage of the model is obvious under all evaluation metrics.

Besides, Figure 9 shows the results of the proposed model compared with the mainstream A, B, C, and D models mentioned above in terms of time overhead (TO). It is clear that the proposed model has better real-time performance while maintaining translation and query accuracy.

4.1. Ablation Studies. In order to analyze the effects of deeply separable convolution, attention mechanism, and each module on the overall model translation query performance, an ablation experiment was conducted. Figure 9 shows the influence of each module on the overall model performance. The ablation experiment is conducted to analyze the influence of the deep-separable convolution, attention

Table 3: Ablation results.

No.	CNN	DSC	AM	NPM	Accuracy (%)	FNR (%)	FPR (%)	F1 (%)	TO (s)
1	√		√	√	94.91	4.69	4.32	95.03	18.60
2		√		√	91.20	7.95	8.04	91.80	9.85
3		√	√		94.37	4.80	4.53	94.32	11.61
4		√	√	√	94.85	4.72	4.36	95.01	10.39

mechanism, and metrics-free learning module on the overall model translation query performance. Detailed results are presented in Table 3, and CNN represents that only CNN is used as the backbone network to map the input statements to the deep feature space. DSC represents depth-separable convolution; AM stands for attention mechanism; NPM stands for nonparametric metric learning module.

According to the experiments in No. 1 and No.4 in Table 3, compared with the traditional CNN as a feature extractor, the depth-separable convolution is used to map the input statements into the depth feature space. Although there is a decrease in accuracy, F1, FNR, FPR, and other evaluation indicators, the decrease is not significant. However, the model translation query time decreases by 44.13% (18.6s⟶10.39s). It shows that the depth-separable convolution introduced in this paper has a positive effect on the reduction of model inference time. According to the experiments of No. 2 and No. 4, although the inference time of AM model introduced with the attention mechanism decreased, accuracy decreased by 3.85% (94.85%⟶91.20%). Therefore, the attention mechanism has a great impact on the overall performance of the model. According to the experiments of No. 3 and No. 4, nonparametric metric learning module has better real-time performance than traditional training mode because there are no learnable parameters and can also improve the overall performance to a certain extent.

5. Conclusion

This paper proposes a query and support decision model for English translation with the big data corpus and applies it to business English translation. Using deep-separable convolution as feature extractor instead of traditional convolutional network can effectively reduce the time overhead. Secondly, the attentional mechanism is introduced into the proposed model to further optimize the performance with strengthening the expression ability of the depth features. Finally, a nonparametric metric learning module is used to improve the model in an end-to-end approach. Compared with all comparison models, the proposed model performs well in translation and query performance and has better real-time performance on the built big data corpus.

In the future work, the proposed model can be deployed to PC and mobile clients to provide timely and convenient translation and query services.

Data Availability

The experimental data used to support the results of this study can be obtained from the author upon request.

Conflicts of Interest

The author declares that there are no conflicts of interest in this work.

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Retraction

Retracted: Evaluation Method and Implementation of Vocal Music Teaching Performance under a Wireless Communication Environment

Security and Communication Networks

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This article has been retracted by Hindawi, as publisher, following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of systematic manipulation of the publication and peer-review process. We cannot, therefore, vouch for the reliability or integrity of this article.

Please note that this notice is intended solely to alert readers that the peer-review process of this article has been compromised.

Wiley and Hindawi regret that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Liu, "Evaluation Method and Implementation of Vocal Music Teaching Performance under a Wireless Communication Environment," *Security and Communication Networks*, vol. 2022, Article ID 2597772, 9 pages, 2022.

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Research Article

Evaluation Method and Implementation of Vocal Music Teaching Performance under a Wireless Communication Environment

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With the development of society, modern educational technology and electronic information technology are more and more closely combined. Auxiliary teaching products based on computer technology, multimedia technology, and network technology emerge one after another. How to combine modern wireless communication technology with modern educational technology to evaluate the teaching effect has become one of the hot topics in the field of modern teaching research. In view of the lack of communication between teachers and students and evaluation methods of the teaching effect in traditional vocal music teaching, this paper designs a method of evaluation of vocal music teaching effect in a wireless communication environment. First, this paper designs a feedback system of vocal music teaching based on wireless communication. Second, due to the influence of vocal music teaching effect, the factors are diverse, and the neural network has the advantages in processing the data with nonlinear strong robustness and dynamic characteristics. And we use BP (back propagation) neural network as a mathematical model to receive teaching feedback information. Then, the simulation results show that the proposed method can not only evaluate the effect of vocal music teaching but also has good feasibility and practicability. Finally, the method proposed in this paper can help improve the teaching level and efficiency of the school and has a great theoretical value and practical potential.

1. Introduction

In the traditional classroom teaching mode, active communication between teachers and students is often lacking [1, 2]. If this goes on for a long time, students will feel bored in learning and lack the sense of participation, and teachers will find it difficult to know how each student has grasped the knowledge in real time, affecting their grasp of the rationality of classroom teaching progress. Therefore, the traditional classroom teaching mode must be reformed in order to meet the increasing learning requirements of teachers and students. In the classroom, teaching and learning go on at the same time, and further preaching is for learning. Therefore, teachers need to use a variety of feedback methods to understand the learning effect of students and adjust teaching methods according to the real-time teaching situation [3]. The traditional teaching feedback methods are mainly divided into the following three types:

(1) Verbal feedback: Teachers analyze students' mastery of classroom knowledge through oral communication such as classroom questioning, classroom discussion, and students' questioning, so as to adjust teaching methods. The disadvantage of this approach is that the feedback information teachers get is somewhat one-sided, and they cannot fully grasp the learning situation of students. Meanwhile, students' attention is distracted due to the lack of sense of participation, leading to the loss of classroom teaching effectiveness.

(2) Written feedback: Teachers observe students' mastery of knowledge and existing problems through blackboard writing, homework, and classroom tests. The disadvantage of this method is that the teachers in the classroom time and energy cannot carry out effective teaching diagnosis for every student. In addition, the phenomenon of plagiarism among students increases the difficulty for teachers to assist.

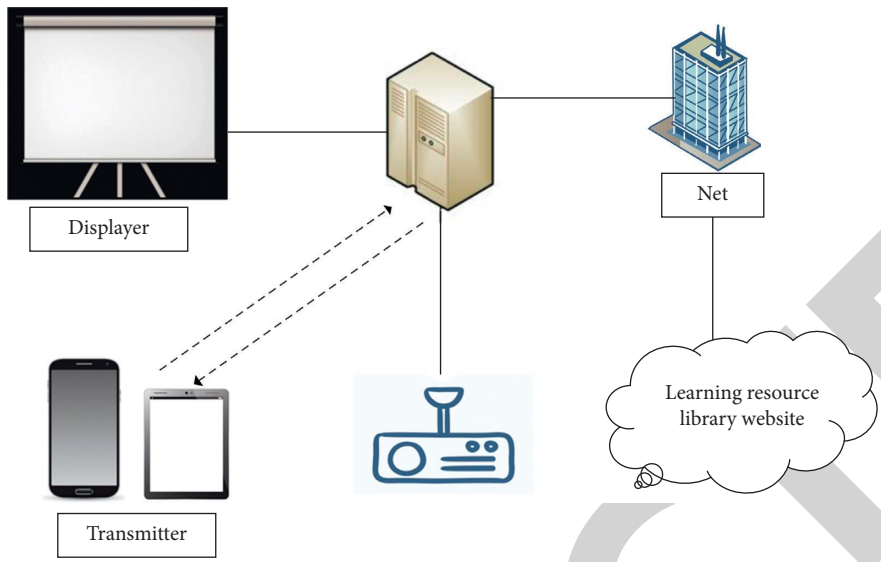

Figure 1: The schematic diagram of the wireless feedback teaching system.

(3) Physical projection display feedback: Teachers show students' learning results through physical projection and multimedia demonstration, so as to understand some specific problems existing in students' learning, so that teachers can carry out targeted classroom teaching [4, 5]. The disadvantages of this approach are similar to verbal feedback. It is difficult to ensure the participation of everyone and cannot accurately grasp the overall classroom teaching efficiency.

With the development of wireless communication technology, the application of wireless communication technology in the field of education has become the key research direction of the new mode of contemporary teaching. At present, the mainstream wireless communication technologies applied in the field of education include bluetooth, RFID, UWB, WiFi, infrared [6, 7]. This technology has the functions of instant evaluation, investigation, statistics, and record, which plays an important role in helping teachers get the feedback information of students in time and adjust and optimize classroom teaching strategies in time. The receiving device of the evaluation system is directly connected to the corresponding network (such as campus network), and the relevant information is transmitted to the server and integrated into the database. The schematic diagram of wireless feedback teaching system is given in Figure 1. The typical wireless feedback teaching system under information technology mainly consists of a set of simple personal handheld signal transmitters and a receiver connected to the classroom computer for signal acquisition. When students answer questions through handheld transmitters, the system will automatically generate various reports required by teachers after receiving signals, and the results will be displayed on the large screen display equipment in the classroom. Teachers can monitor students' learning progress in real time, analyze students' learning effect according to the feedback data and adjust the corresponding teaching content and progress [8, 9].

Common short-range wireless communication technologies are described as follows. IrDA technology, commonly known as infrared communication technology, uses infrared light for point-to-point communication. The wavelength of infrared ray is invisible. The near infrared in the infrared band is used for infrared communication. The IrDA standard is a point-to-point data transfer protocol and an alternative to connecting cables between traditional devices. Its advantage lies in not needing to apply for frequency use right, and communication cost is low. Second, red outside communication uses light to transmit data, and there is no problem of wireless channel resources being occupied and has strong anti-interference and high security. Third, high data transmission rate is suitable for large-capacity file and multimedia data transmission. Fourth, infrared equipment has the characteristics of small volume, low power consumption, easy to use, and so on required by mobile communication. After years of development, the hardware and software technology related to infrared communication technology has been very mature, and the range of use is more and more extensive. Bluetooth technology has the following advantages: it works in the global open frequency band, has high data transmission rate, and has secure communication; it can bypass obstacles to connect within the effective range and has no requirements on communication perspective and direction. At present, bluetooth technology has been widely used in household automotive electronics, information equipment, industrial equipment, and household appliances, especially in the application of personal LAN. Wi-Fi technology is a kind of short-distance wireless communication technology. Compared with bluetooth technology, Wi-Fi technology is inferior in data security, but better in radio wave coverage, which can fully meet the application needs of families, offices, and even small buildings. The advantage of WiFi technology lies in the wide range of radio waves, covering a radius of about 100 meters. In addition, the transmission speed is very fast, reachable, and penetrable. Radio frequency

technology is radio frequency identification and is also a short-range wireless communication technology. The realization of radio frequency technology requires the use of radio frequency transceiver chip. These radio frequency modules are widely used in civil and industrial fields due to their low power, high reliability, and easy development. However, this RF module has a slow data transmission speed and small data flow, so it is only suitable for building small networks.

The rapid development of education changes the evaluation system in education [10, 11]. In recent years, teaching effect evaluation, as a new evaluation method, has attracted wide attention and has become a research hotspot in the field of international education evaluation. Teaching effect evaluation can not only evaluate students' knowledge and skills but also comprehensively evaluate students' practical ability, exploration ability, innovative spirit, and emotional attitude. Vocal music, as a required course for undergraduate students, is a main course to train students to have the basic ability of music education. This course is a combination of practice, knowledge, skill, and artistry. Combining with the characteristics of this course, the author thinks that the evaluation process of vocal music course is a systematic teaching activity, and the evaluation method of teaching effect is suitable for it and can become possible. At present, the research results of performance evaluation by foreign scholars have been relatively comprehensive and in-depth, and the domestic academic circle has introduced it more, and there are also more scholars to evaluate and score the teaching effect of foreign mature standards. Although we can learn from some foreign theoretical research results, we need to combine the social background of our country, education practice to carry out specific research on the teaching effect of our country, design suitable for the teaching effect evaluation method of our students. Therefore, combined with their own teaching practice, the author from the vocal music course in the process of vocal music teaching design based on the wireless communication environment vocal music teaching effect evaluation method tries to promote the construction and development of new music art course teaching evaluation system from the perspective of vocal music course teaching evaluation [12, 13].

2. Related Work

Computer application in the field of education, and as a modern teaching aid and tool, began in the 1950s. From the birth of the early 50s linear program, branch, generation system, and the computer-assisted instruction system, so far nearly 30 years of research of the intelligent teaching system is put forward and its development, and it serves to show the computer technology application in the field of human education and development speed, the form of diversification and became popular [14, 15]. The idea of intelligent education application has appeared in the period of computer aided education, but the degree of realization of the idea is different in different periods. Because the role of computer in education and teaching, on the one hand, is closely related to the development level of computer technology and also related to the degree of application and demand in different fields of education. Therefore, in the intelligent application of computer in education, from its development process, there are roughly computer-assisted teaching, intelligent teaching system, intelligent network teaching platform, and other representative application modes. The intelligent teaching system was produced in the early stage of artificial intelligence application in education, involving the comprehensive fields of artificial intelligence, computing science, psychology, and pedagogy. The purpose of this study is to make computers play the role of teachers and endue them with intelligent behaviors to replace teachers to become learners' guides and helpers to a certain extent, so as to achieve individualized teaching and individualized teaching effect. The intelligent teaching system in the user interface, teaching content and teaching process, and other aspects of a more comprehensive design mainly reflects the detailed description of the course, teaching course learning and learning process evaluation and other functions and at the same time, in the multimedia, teaching a set of speech synthesis, image display technology, with good man-machine interaction dialogue function [16, 17].

Any kind of teaching evaluation method should be put into practice, not only should there be feasible evaluation plan but also have clear teaching evaluation operation procedures. What needs to be further considered is that in order to break the disadvantages of the traditional vocal music teaching evaluation model, we must deeply explore the real connotation of formative evaluation and summative evaluation, and master the specific operation methods and implementation procedures. At present, the study of performance evaluation by foreign scholars is more thorough and comprehensive, and there are many related works. Many educational experts have been engaged in performance evaluation research for a long time, which has formed a relatively perfect theoretical system and has been widely used in practice. In recent years, there have been systematic researches on it. Through the above elaboration, we should transform the specific teaching goal of vocal music teaching into the specific behavioral stage goal that can be observed; that is, the teaching process can be clearly used to guide evaluation activities and improve learning efficiency standards. Specific studies are as follows:

(1) Master basic theoretical knowledge of vocal music, with basic theoretical level and understanding ability of vocal music art. Cultivate students' correct singing posture, positive singing psychology, and good singing habits.

(2) Understand the rules of Chinese and foreign singing languages, sing Chinese adapted songs in standard Mandarin with clear articulation and natural pronunciation.

(3) Establish the correct concept of sound, train the students to use the correct breathing method, strive to achieve the stability of larynx when singing, develop good habits of clauses and breathing, and use the breath to support the sound of singing.

(4) Train students to have the ability to understand and analyze songs, learn knowledge and skills, and sing different types of songs and to cooperate with accompaniment, resulting in more complete expression of the ideological mood of the song.

At present, in the vocal music teaching of normal colleges in our country, most of the students only stay on the evaluation of vocal music training and singing, and most of the students stay on the evaluation of skills, resulting in a single and narrow knowledge structure in the field of vocal music [18, 19]. Now with a final exam to determine the score, it will let teachers and students lose a lot of opportunities to expand teaching content and improve learning in the teaching process, but also sacrificed a lot of poor basic conditions of the general students of vocal music learning interest, making the realization of teaching goals became an empty talk. Therefore, at present, the music education curriculum in normal colleges is expanding day by day, and the number of vocal music classes cannot be increased. It is practical and worthy of attention to change the past teaching methods, interlace important theoretical knowledge of vocal music in the teaching of vocal music training and singing, and expand the evaluation content and methods of vocal music training and singing in the cognitive field. Since the perception and imagination of music are not easy to measure, it is not suitable to adopt strict quantitative evaluation but comprehensive evaluation to evaluate the training and singing of vocal music students in normal universities. The most reasonable evaluation is mainly formative evaluation, supplemented by summative evaluation. In the traditional vocal music teaching process, in fact, formative evaluation is everywhere, and its process is more important than the result; once the skill is formed, it is difficult to correct. Due to the expansion of teaching objectives and evaluation standards, the corresponding evaluation means and methods are also greatly increased [20, 21]. Vocal music art is the art of emotional experience, and in order to cultivate students' interest in music, it is necessary to pay attention to create an artistic atmosphere to infect students in the teaching process and pay attention to the development of latent music courses. On this basis, there are specific evaluation methods: observation method, essay test, questionnaire method, grade scale method, and so on. As the evaluation criteria and evaluation content have been diversified, the above evaluation methods should not be used singly but throughout the whole teaching process. According to the different evaluation information content to be collected, various evaluation methods can be integrated.

In the evaluation of students' mastery of vocal music theory knowledge, since many vocal music theory learning can only be interspersing in the process of vocal music training and singing teaching, summative evaluation should be given priority, and formative evaluation should be supplemented [22]. The purpose of summative evaluation is to comprehensively evaluate students' achievements in a certain course or its important part, and the summative test is the main means. At the end of the study, teachers prepare test questions for students to assess, in the formulation of vocal music theory knowledge of the test paper, attention should be paid to, first of all, the preparation of test questions which must be consistent with the teaching content in line with the requirements of teaching objectives. Second, the proportion of test content can be arranged reasonably according to the cognitive level to improve the credibility and value of the test paper. Taking the cognitive goal of Chinese phonetic knowledge of vocal music language as an example, if too much of the test questions stay in the stage of knowledge objective assessment, then the value of this test paper is very low, and it cannot effectively assess the comprehensive ability that students really should have. In vocal music theory course of study, as an auxiliary formative assessment should be present throughout the course of the teaching process, andthe main purpose of the formative assessment is not to give students grades or provide proof but a determination of a specific learning tasks to master degree, and it also helps teachers to help students focus on should grasp the specific knowledge [23].

Compared with the traditional teaching methods, the Physics Department of the University of Illinois began to implement the interactive classroom teaching reform in physics education research, and successfully established the wireless communication teaching mode. After this model was introduced to Harvard University, physicists at the University of Illinois were inspired to develop the radio frequency system iClicker, which is an interactive answering machine similar to a wireless remote control. In the actual use process, the system is improved and optimized constantly, making its performance more stable and reliable. Subsequently, Macmillan acquired the remote answering interactive teaching system technology, and within a few years, it was promoted to colleges and universities in the United States, making it the most widely used wireless communication teaching evaluation system. Now, the company is developing a tele-qin interactive teaching system based on satellite communication that will allow students to study at home as interactively as they do in the classroom. At present, the wireless conference voting system is more popular in the domestic market. There are few interactive response systems dedicated to classroom teaching, and the research and application of this system is still in its infancy. Of course, some domestic enterprises have been committed to the research and development of interactive teaching products. These companies to imitate the technology of American companies mainly use radio frequency technology and infrared remote control technology as a means of communication because developers do not work in the front line of teaching. Therefore, their system is not very close to the actual classroom teaching needs. So far, no Chinese universities have officially started to use the system.

Although there are few interactive teaching systems in China, there have been many researches on the teaching system based on wireless communication technology [24]. The wireless feedback teaching system has been studied earlier in foreign countries, and the classroom feedback system is widely used in universities, primary and secondary schools, and the practical application effect is obvious. At

present, in the United States, including Harvard University, Ohio State University, Purdue University, University of Washington, and other world-class universities, as well as a large number of primary and secondary schools in the classroom use IRS (interactive response system), which generally improves the quality of teaching and learning efficiency. At present, the application scope includes the United Kingdom, Japan, South Korea, Malaysia, and other countries and regions, and the practical application effect is remarkable; in the United States, it has more than 1 million users. The wireless feedback teaching system has been studied earlier in Taiwan and widely used in primary and secondary schools in Taiwan and has been popularized in primary and secondary schools in mainland China. It has a promising application in university classrooms. At the beginning, Central University in Taiwan began to study how to integrate teaching feedback with technology, and the doctoral team designed related technical products. Learners can enhance their learning ability through classroom learning or the Internet, in a learning community with peers, teachers, and parents. In 2010, there are more than 3000 experimental classes in Taiwan, and nearly 8000 sets of related technology products are applied to teaching activities worldwide. In 2016, the IRS application in Taiwan is further common, and even some schools have reached a machine. At present, experimental classes based on the wireless communication feedback system have been carried out in more than 1000 primary and secondary schools in more than ten provinces and cities in China, such as Beijing, Shanghai, and Guangdong.

Through sorting out the above literature, we can clearly find that the research on the theory and practice of vocal music teaching evaluation in China is still in the initial stage, still stays at the initial level of introduction of teaching evaluation, still belongs to the practice stage at will, and has not yet formed a systematic theory. The evaluation process shows subjectivity and arbitrariness, and the implementer himself lacks in-depth understanding and lacks empirical research on the implementation procedures and methods of vocal music teaching evaluation, so the whole evaluation is quite chaotic [25]. The specific problems can be summarized as follows: the content of the evaluation is too single, focusing on the mastery and application of vocal music skills, and the lack of evaluation of the overall knowledge structure and comprehensive ability of students. The way of evaluation is too monotonous, focusing on the summative evaluation and quantitative evaluation method (i.e., the final examination), and lack of comprehensive and objective evaluation to reflect the progress of students' vocal music learning and promote their overall development. The main body of evaluation is teachers, ignoring the status of students in the evaluation and the importance of students' self-evaluation, mutual evaluation, and other evaluation. The evaluation function tends to discriminate students' singing skills, deviates from the evaluation principle of vocal music teaching and the goal of students' overall development, and affects the change of vocal music teaching concept and the improvement of teaching methods. In view of the existing problems of vocal music teaching evaluation in our country, we put forward a method of vocal music teaching effect evaluation under the wireless communication environment, which has been accepted in many evaluation fields. It will break the disadvantages of traditional teaching evaluation, accompany the whole process of students' learning, and promote students' all-round development. Based on the above discussions, the contributions of this paper can be concluded as follows:

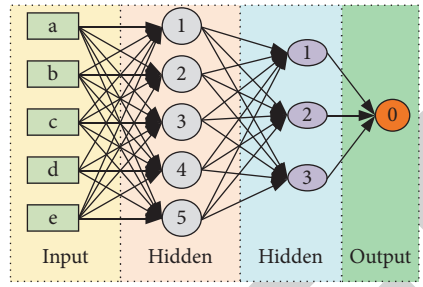

Figure 2: The diagram of BP neural network.

(1) This paper is the first to evaluate vocal music teaching effect by using the neural network model in wireless communication environment

(2) The research of this paper not only has certain theoretical value but also has potential application prospect

3. Materials and Methods

3.1. BP (Back Propagation) Neural Network. The diagram of BP neural network is given in Figure 2. The error is less than a certain value, and it indicates that the network training is completed.where x_i is the real value and c_i is the predicted value. Then, the hidden layer can be expressed as

$$E = \sum_{i=1}^{m} (x_i - c_i)^2, \tag{1}$$

$$E = \frac{1}{2}\sum_{\kappa=1}^{\ell} [d_\kappa - f(\text{net}_\kappa)]^2 = \frac{1}{2}\sum_{\kappa=1}^{\ell}\left[d_\kappa - f\left(\sum_{j=0}^{m}\omega_{j\kappa}y_j\right)\right]^2. \tag{2}$$

Expanding further to the input layer, there is

$$E = \frac{1}{2}\sum_{\kappa=1}^{\ell} d_\kappa - f\left[\sum_{j=0}^{m}\omega_{j\kappa} f(\text{net}_j)\right] = \frac{1}{2}\sum_{\kappa=1}^{\ell} d_\kappa - f\left[\sum_{j=0}^{m}\omega_{j\kappa} f\left(\sum_{j=0}^{n} v_{ij}\chi_i\right)\right]^2. \tag{3}$$

It can be seen from the above formulas that the network input error is a function of the weights of each layer, so the error can be changed by adjusting the weights. Obviously, the principle of adjusting weights is to reduce errors continuously, so the weights should be proportional to the gradient descent of errors. Since formulas (4) and (5) are partial derivatives of process data, their values range over the entire real number field.

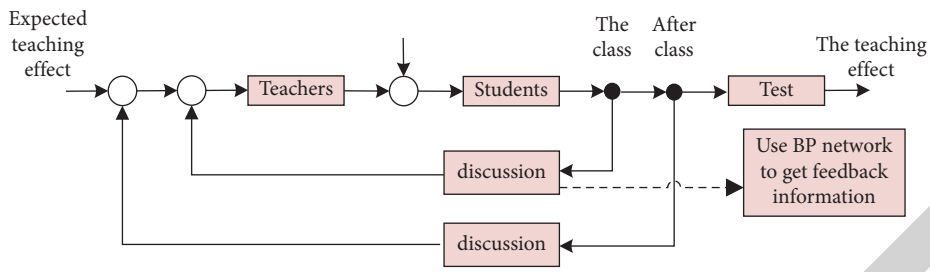

Figure 3: Teaching process based on the wireless feedback system.

$$\Delta\omega_{j\kappa} = -\eta\frac{\partial E}{\partial\omega_{j\kappa}} \quad j = 0, 1, 2, \ldots, m;\ \kappa = 1, 2, \ldots, \ell, \tag{4}$$

$$\Delta v_{ij} = -\eta\frac{\partial E\ \partial}{v_{ij}} \quad i = 0, 1, 2, \ldots, n;\ j = 1, 2, \ldots, m. \tag{5}$$

Then the weight adjustment formula of each layer is

$$\Delta\omega_{j\kappa}^{h+1} = \eta\delta_{h+1}^{\kappa} y_j^h = \eta\left(d_\kappa - o_\kappa\right)o_\kappa. \tag{6}$$

According to the above rule layer by layer analogy, the weight adjustment formula of the first hidden layer is

$$\Delta\omega_{pq}^1 = \eta\delta_q^1\chi_p = \eta\left(\sum_{r=1}^{m_2}\delta_r^2\omega_{qr}^2\right)y_q^1. \tag{7}$$

The differential evolution algorithm (DE) is introduced into the neural network to optimize the initial weights and thresholds of the network. Hence, the DE algorithm optimizes network parameters to obtain better model performance:

$$x_{i,1} = x_i^L + \mathrm{rand}\left(x_i^U - x_i^L\right), i = 1, 2, \ldots, NP. \tag{8}$$

The mutation operation formula is as follows:

$$v_{i,G+1} = x_{r1,G} + F\left(x_{r2,G} - x_{r3,G}\right). \tag{9}$$

Then the interlace operation is

$$u_{ji,G+1} = \begin{cases} v_{ji,G+1}, & r_j \le CR\ or\ j = \mathrm{rand}\,(i), \\ x_{ji,G}, & r_j \ge CR\ or\ j \ne \mathrm{rand}\,(i). \end{cases} \tag{10}$$

Accordingly, the selection operations are as follows:

$$x_{i,G+1} = \begin{cases} u_{i,G+1}, & f\left(u_{i,G+1}\right) \le f\left(x_{i,G}\right), \\ x_{i,G}, & f\left(u_{i,G+1}\right) > f\left(x_{i,G}\right). \end{cases} \tag{11}$$

The fitness function is

$$f\,(X) = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(Y_i^0 - Y_i\right)^2}. \tag{12}$$

Because traditional BP neural networks is prone to local optimum, some optimization algorithms can be used to optimize the parameters of the model, but due to the length of the paper, it will not be described here.

3.2. Wireless Feedback System. The classroom feedback teaching model constructed by us is shown in Figure 3. Students are the controlled objects, teachers are the controllers, and the teaching content can be regarded as the disturbance input of the system. The feedback information includes timely feedback information, delayed feedback information, and self-feedback information. As can be seen from the figure, homework and quizzes can provide quantitative delayed feedback information, which is convenient for teachers to make statistics and analysis, and for students to compare their scores. However, in the traditional mode, it is difficult to provide quantitative feedback information for statistics and analysis in the way of answering questions and discussing in class. The feedback effect mainly depends on the experience and teaching level of teachers, and sometimes it will become a negative feedback due to unfavorable organization. Therefore, neural network can be used to obtain quantitative instant feedback information in classroom feedback teaching. The two discussions are different, one of them is from the class and the other is after class.

4. Results and Analysis

4.1. Experimental Data Introduction. In order to understand the present situation of vocal music course teaching evaluation in normal colleges more accurately and in detail, the feasibility and superiority of performance evaluation in vocal music course are analyzed carefully. Before the experiment of performance evaluation, the author selected undergraduate students majoring in musicology in a university to interview. The interview was conducted in the first semester of the year. In order to ensure the coverage of survey subjects, the author selected 600 interviewees in the whole grade and divided them into 30 groups. A total of 600 interview records were collected with a recovery rate of 100%.

In addition, the students of music major and nonmusic major of the school were surveyed, and the data of the survey included students' scores on the teaching effects of different teachers, and the answers of music teaching tests of students of different grades and so on.

4.2. Experimental Results Analysis. The method framework proposed in this paper is mainly embedded in BP neural network, but because BP neural network is just a general feedforward network, and it cannot process large-scale vocal

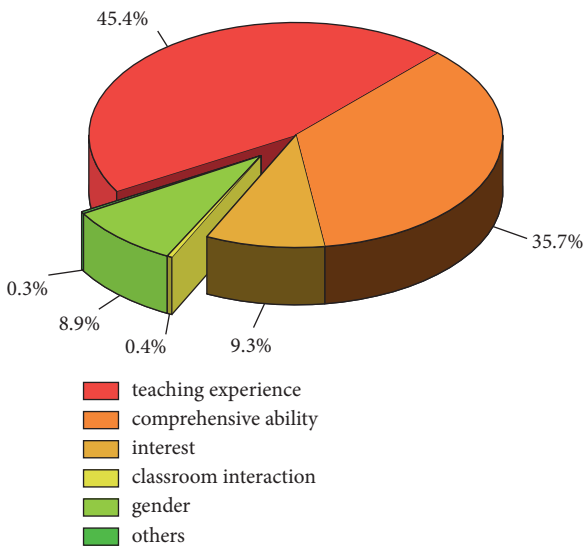

Figure 4: The main influencing factors of the vocal music teaching effect.

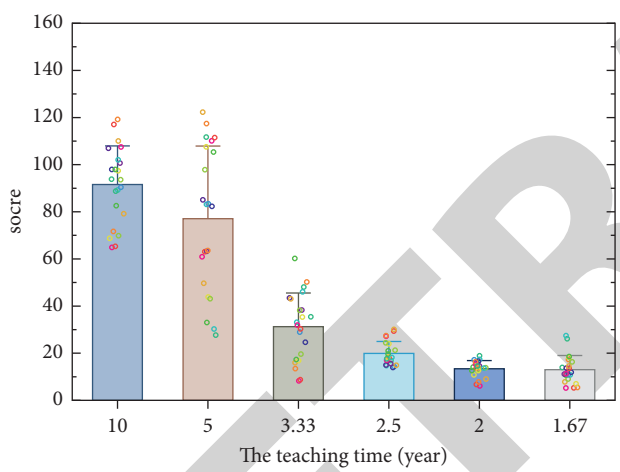

Figure 5: The relationship between teachers' seniority and scores.

music data, so it is difficult to apply to big data scenarios. First of all, Figure 4 shows the main influencing factors of vocal music teaching effect (determined by manual experience and questionnaire survey). Among them, teachers' teaching experience accounts for the highest proportion, accounting for 45.4%. The second is the students' comprehensive ability (including understanding ability and expression ability), accounting for 35.7%. The third and fourth most important factors were students' interest and classroom interaction, accounting for 9.3% and 8.9%, respectively. Gender and other factors accounted for almost nothing.

We take the teacher's experience as the independent variable, and study the relationship between teaching experience and students' rating of teachers by the equivalent teaching hours and the teacher's teaching experience (shown in Figure 5). As can be seen from the figure, teachers' teaching hours are directly proportional to students' ratings of teachers, which is also consistent with our life experience.

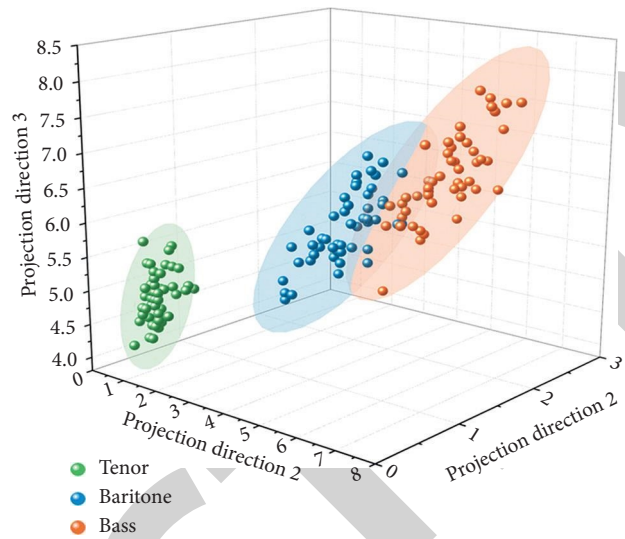

Figure 6: Extraction results of three vocal features based on wireless communication.

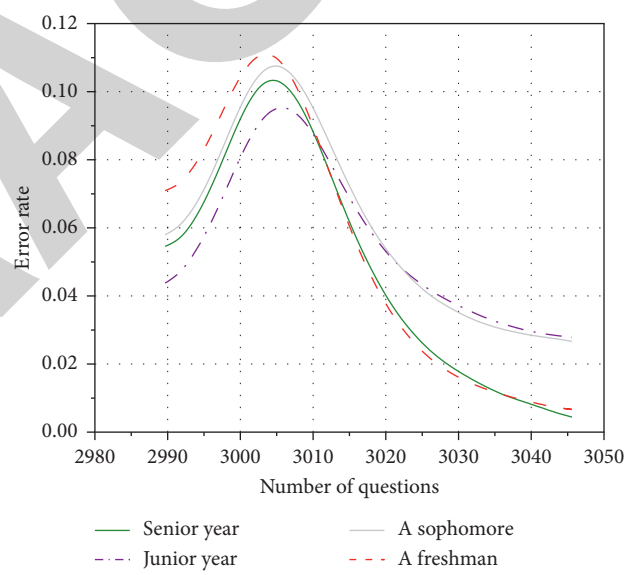

Figure 7: The relationship between the number of answer times and the error rate of students in different grades.

Specifically, the average score of teachers with 10 years of teaching is around 90, which means that students are satisfied with the teaching effect of teachers. Similarly, teachers' scores declined as their years of teaching decreased. This further verifies that the teacher's teaching age is the most important factor affecting the vocal music teaching effect. Among them, colored scatter points represent the distribution of teachers' scores, and this paper mainly solves the mean value of these scatter plots to determine the final score of each teacher.

Besides, we have taken three different vocals (tenor, baritone, and bass) and were used to verify the vocal feature extraction effect of the proposed method. The vocal features are extracted by BP neural network in wireless communication environment and then input into the t-SNE (t-

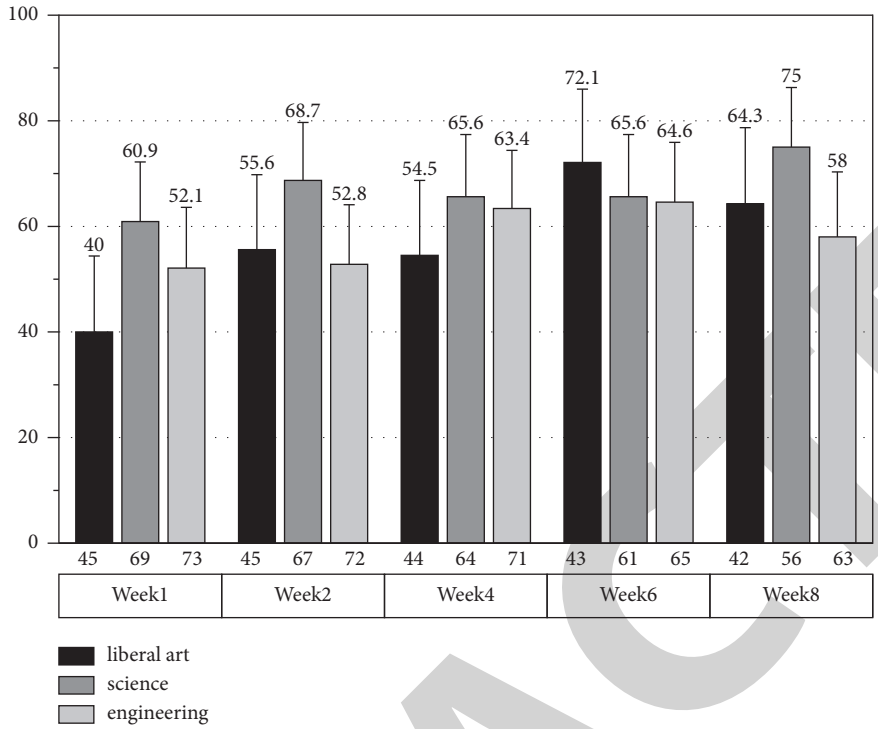

Figure 8: The improvement of the teaching effect of arts, science, and engineering students after the application of the system.

distributed stochastic neighbor embedding) model for dimensionality reduction. The results are shown in Figure 6, from which we know that the evaluation method of vocal music teaching in this paper can classify three kinds of vocal music characteristics well, which is conducive to the visual display of different entrance schools, so as to provide teaching effects. Although there are many types of vocal music, in order to verify the effectiveness of this method, we use the three most representative vocal music to verify, namely tenor, baritone, and bass. Thus, the validity of the method in this paper is illustrated.

Figure 7 shows the relationship between the number of questions and the error rate of students in different grades under this teaching system. In general, with the increase of the number of questions, the vocal music teaching system designed can effectively reduce the error rate of students in different grades especially for the freshmen although their vocal music level is not as high as the senior students at the beginning, but after the systematic training, freshmen can obtain the lowest error rate. The errors of the remaining grade students also achieved varying degrees of reduction. However, there is a period of time in the figure where the error rate of the answer shows a rising trend mainly because the model does not have enough training samples, which leads to the under-fitting situation of the model. However, with the increase of the number of questions, the error rate gradually decreases, indicating that our method can achieve a good vocal music teaching effect.

In order to further demonstrate the effectiveness of the proposed method to improve the vocal music teaching effect, Figure 8 shows the degree of improvement of teaching effect of arts, science, and engineering students after the system. As can be seen from the figure, with the passage of time, the vocal music teaching effect of students of different disciplines presents a rising trend. In particular, liberal arts students saw a 72.1 percent improvement in their sixth week of teaching, while science students saw a 75 percent increase in their eighth week of teaching. Engineering students also saw the biggest improvement in their sixth week with 64.6 percent. From the above results, it can be seen that the method in this paper can evaluate the effect of vocal music teaching well, and the method has good universality.

5. Conclusions

Evaluation is an important link in teaching, and its implementation is inseparable from other links in the teaching system, which needs the chain reaction of teaching material content, teaching methods, and other factors. At present, people's understanding of the concept of teaching evaluation still has a misunderstanding, always regard evaluation as simple as examination or test. The separation of evaluation from the students' learning process has seriously hindered the development of vocal music teaching, and the perfection of teaching evaluation has become an urgent problem to be solved.

Aiming at the disadvantages of traditional vocal music teaching evaluation, we put forward the vocal music teaching evaluation method based on wireless communication technology. After a semester of experimental observation, this study went deep into students' classroom and worked closely with vocal music teachers. The experimental results can fully show that the application of wireless communication technology in vocal music teaching teaching

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Retraction

Retracted: Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Bai and Y. He, "Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion," *Security and Communication Networks*, vol. 2022, Article ID 1971341, 10 pages, 2022.

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Research Article

Influence of Teaching and Course Evaluation of Performing Arts Students Based on Improved Ant Colony Algorithm and Data Fusion

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Teaching quality evaluation plays a very important role in the evaluation of teaching and learning in universities, especially in performing arts courses. Therefore, in this study, the application and detailed analysis process of clustering analysis on student performance data is used to finally obtain the guidance of clustering results on teaching and management. A mathematical model of teachers was established using graph theory to transform the evaluation process into a bipartite graph model and to fully utilize the memory capacity, mastery of prior knowledge, adaptability, and collaboration of the ant colony algorithm. Moving back and forth between the two sets of partial graphs completed the evaluation of the teacher teaching process. In addition, the maximum and minimum pheromone strategies were applied in the original ant colony algorithm; the robustness of the algorithm itself was enhanced by making full use of the memory ability and the necessary prior knowledge mastery in solving the teacher teaching evaluation problem. For the unqualified teachers, according to the principle of PDCA (quality environment), regular training, mutual lectures, and further training can be adopted to improve teachers' teaching levels. Through comparison, it is found that the general and practical courses of art performance majors do not have professional characteristics, and the professional courses are mostly dance and performance courses, while physical education, sports training, and other related courses are insufficient. Through the method of this study, all students are concentrated in the group of teachers with higher satisfaction, and "teaching" can achieve the expected effect and provide theoretical and practical basis for the development of performing arts courses.

1. Introduction

Colleges and universities are an important link in cultivating the successors of socialism in China, and realizing the effective combination of physical education in colleges and universities and social sports needs is effective in improving the quality of physical education in colleges and universities and meeting social sports needs [1, 2]. The monotony of mass sports in sports and its traditional development mode have made mass sports lose vitality in development, which is also the main factor leading to the stagnation of mass sports. The emergence of art sports has brought new popular ways to the current mass sports [3]. While the development of popular sports is stagnant, the process of teaching physical education in colleges and universities is also a "bottleneck" phenomenon [4]. This also puts forward new requirements for the cultivation of sports talents in colleges and universities, especially the cultivation of sports and artistic talents [4]. Literature [5] published the first article on the professional talent cultivation of art performance course and proposed the "one, three, one" professional talent cultivation model of art performance course, namely, the interpretation of "one profession," which answers the question of what is a performance profession; " the interpretation of "three abilities," performance ability, teaching and training ability, and choreography ability, which answers the question of what people should be cultivated in performance profession; the "one-way" analysis, which answers the question of how

to cultivate. This mode of cultivation has influenced the cultivation of professional talents in art and performance for a period of time. Literature [6] published an article "A Re-Examination of the Development of Art Majors in Sports Colleges and Universities in China," pointing out that the establishment of art majors in colleges and universities has become a trend due to the unclear positioning of the majors and confusion in curriculum settings. The problems restrict the development of art majors." Sports colleges and universities running good art majors can effectively enhance the brand and influence of the school" [7, 8]. Therefore, all 14 independently set up sports colleges and universities announced by the Ministry of Education have offered art majors [9, 10]. However, "when higher education changes from scale development to quality development, the problems surrounding the construction of sports and arts majors gradually come to the fore, and the construction of majors faces a series of difficulties" [11, 12]. Existing studies on the cultivation of artistic talents in colleges and universities mainly explore the talent cultivation model from a macro perspective and lack analysis and discovery of the characteristics of artistic talents cultivation in sports colleges and universities from the perspective of curriculum setting.

In this study, the PDCA ant colony algorithm is applied to teaching evaluation [13, 14], a relevant algorithmic framework is proposed, and a mathematical model of teachers is established using graph theory to realize the evaluation of teachers' teaching process in order to effectively improve teaching quality and students' motivation to learn. Cluster analysis is an important method in data mining, which is widely used in pattern recognition, data analysis, image processing, market analysis, and other fields to find the patterns of similar objects [15, 16]. In teaching evaluation, it is necessary to find out the different factors affecting learning motivation and teaching effectiveness, as well as the reasons for teaching differences among different teachers. Cluster analysis can extract various valuable information from the raw data of teaching evaluation, analyze the characteristics of different types of courses, and provide strong support for evaluating courses and improving teaching.

Aiming at the disciplinary background and the current situation that the basic system and theoretical research of sports and arts courses are in the early stage, we conduct relevant research on the development of sports and arts programs in public physical education courses in colleges and universities, in order to help enrich and improve the teaching theories of physical education disciplines, provide a certain theoretical basis for the development and direction of the future development of sports and arts programs in college sports, and provide the reform of physical education teaching in general colleges and universities. It is expected to provide a theoretical foundation and basis for the reform of physical education in general colleges and universities.

2. Ant Colony Algorithm Based on PDCA Cycle

2.1. Classical Ant Colony Algorithm. The ant colony algorithm (ACO, ant colony optimization) is inspired by ants foraging, in which ants find the shortest path to food without being told where the food is in advance and can search for new paths according to the change of environment [17, 18]. The main reason is that ants release pheromones on the paths they pass through, which mainly include road information and information intensity, guiding more ants to travel in the direction with more pheromones. ACO is a probabilistic algorithm to find the optimal path by the amount of pheromones. At time t, the probability that ants $(k = 1, 2, \ldots, n)$ choose node j at node i is as follows:

$$P_{ij}^{k} = \begin{cases} \dfrac{\tau_{ij}^{\alpha}\eta_{ij}^{\beta}}{\sum_{j\in U_k}\tau_{i,s}^{\alpha}\eta_{i,s}^{\beta}} & j \in U_h \\ 0, & j \notin U_k \end{cases}, \tag{1}$$

where τ_{ij} is the pheromone between node i, j; $\tau_{i,s}$ is the pheromone between node i, sin k; η_{ij} is the heuristic factor, indicating the visibility factor, usually $\eta_{ij} = 1/d_{ij}, d_{ij}$ is the distance between nodes $i \sim j$. α indicates the information heuristic factor, generally $\alpha = 1$–5, β expectation heuristic factor, generally $\beta = 1$–5, α optimal value in about 1, and B between 2 and 5 is optimal.

After T moments, one cycle of ants ends, and each path pheromone is adjusted according to the following equation:

$$\tau_{ij}(t + T) = (1 - \rho)\tau_{ij}(t) + \Delta\tau_{ij}, \tag{2}$$

where $\Delta\tau_{ij}$ denotes the pheromone increment of path (i, j) in this cycle, ρ is the pheromone decay coefficient, and taking $\rho < 1$ can prevent the infinite accumulation of pheromones on the path.

2.2. PDCA Cycle-Based Ant Colony Algorithm Framework. The PDCA cycle, also called the quality cycle, consists of four parts, plan, do, check, and adjust, and is a trapezoidal ascending cycle. The general idea of the ant colony algorithm based on the PDCA cycle is shown in Figure 1. The university supervises and manages the teaching process of teachers through the teaching management department. The teaching department develops the curriculum for different grades of each major under the guidance of the syllabus according to the special characteristics of each discipline. In the algorithm, only the course number, the instructor, and the students' satisfaction with the course are required. In the teaching process of teachers, as a course may be taught by several teachers and a particular teacher may teach several courses, students have an overall evaluation of the teacher through their studies. This evaluation can be done in both direct and indirect ways. The direct approach means that students make their evaluations by directly listening to the teacher's class; the indirect approach means that they make their evaluations through the evaluations of other students and upperclassmen. This concept is similar to the basic principle of the ant colony algorithm: the ant itself is a weak individual, but it can coordinate and cooperate with each other to accomplish relatively complex tasks through the colony effect. Pheromones are the key to ant colony communication and coordination. In this algorithm, students' direct and indirect evaluations of teachers are considered as

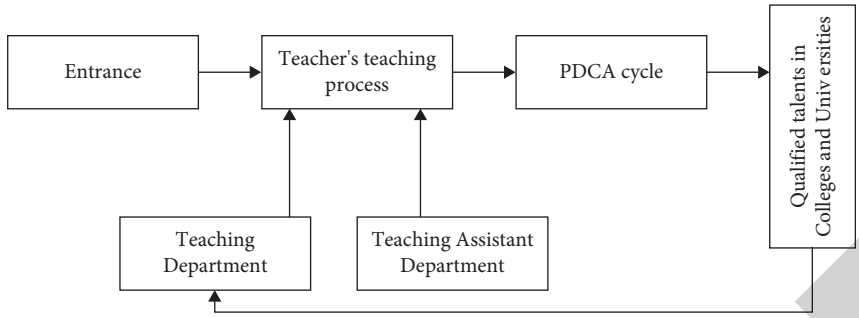

Figure 1: Framework structure of ant colony algorithm based on PDCA cycle.

pheromones, and through the cooperation and interaction of pheromones, all students are concentrated in the group of teachers with higher satisfaction, thus making "teaching" achieve the desired effect.

2.3. Algorithm Description

(1) *Determination of Weights*. A class as a whole is abstracted as an ant, and each ant must have the ability to remember. The weights are determined by comparing the data in the relational model G. A PG taboo list is provided for each ant to record whether the current ant has been assigned out or not. the PG table needs to be continuously updated and needs to be emptied in time before the next start.

(2) *Teacher-Course Matching*. For a teacher who can teach multiple courses and a course can be taught by multiple teachers, it is necessary to find which teacher is most suitable to teach which course in the relational model. This is similar to the ant colony algorithm, in which ants complete a match and compare it with the last best match to find the one with the highest weight among all edges with entitled values.

(3) *Pheromone Selection*. Pheromone is the degree of influence of students who have completed a course on new students taking a course instructor. Pheromone volatile characteristics include the teacher's mood and state of the day, as well as other factors influence, should also include the student's learning state of the day.

(4) *The Effective Use of Positive and Negative Feedback of the Algorithm*. In order to prevent the algorithm from converging too early and the operation time being too long, the pheromone strategy in MMAS algorithm is selected, and probability selection is applied in the algorithm in order to meet the requirements of the algorithm for randomness.

3. Mathematical Model of Ant Colony Algorithm Based on PDCA Cycle

3.1. Mathematical Model. The above ACO is slow in convergence and poor in global search capability, so it has limitations in direct application to the PDCA data fusion algorithm with a large number of sensor nodes. In addition, the ACO does not take into account the node energy, which may lead to the premature death of the cluster head node if it is applied directly. To address these problems, we try to make some improvements to ACO:

$$P_{ij}^{k}(t) = \begin{cases} \dfrac{\left[\tau_{ij}(t)\right]^{\alpha}\left[\eta_{ij}\right]^{\beta}}{\sum_{s\in \text{alowed}_{*}}\left[\tau_{is}(t)\right]^{\alpha}\left[\eta_{is}\right]^{\beta}} & j \in \text{allowed}_{k}, \\ 0 & \end{cases} \tag{3}$$

$\text{tabu}_k\,(k = 1, 2, 3, \ldots n)$ denotes the set of all nodes currently traveled by ant k and allowed_k denotes the set of untraveled points by ant k:

$$\begin{aligned} \tau_{ij}(t+n) &= (1-\rho)\cdot\tau_{ij}(t) + \Delta\tau_{ij}, \\ \Delta\tau_{ij} &= \sum_{k=1}^{m}\Delta\tau_{ij}^{k}, \end{aligned} \tag{4}$$

where ρ denotes the pheromone volatilization factor, then $(1-\rho)$ denotes the pheromone residual factor, and $\Delta\tau_{ij}$ denotes the pheromone increment on path (i, j) in this cycle and denotes the amount of information residual on path (i, j) by the k th ant in this cycle:

$$\Delta\tau_{ij}^{k} = \begin{cases} \dfrac{Q}{L_k} \\ 0 \end{cases}. \tag{5}$$

If the kth ant passes through (i, j) in this cycle,

$$\eta_{ij} = \frac{1}{\left(100 - d_{ij}\right)}, \tag{6}$$

where d_{ij} is the degree of student satisfaction with a particular course taught by a particular instructor. The parameters in the algorithm, such as the information heuristic factor α, the expectation heuristic factor β, the number of ants m, and the fluctuation factor ρ, are derived from the TSPLIB simulation experiments on the scheduling class of problems based on the ant colony algorithm. In the algorithm, $m = 5$, maximum number of iterations = 40, $\alpha v = 1$, $\beta = 5$, $\rho = 0.3$, $\tau_{\max} = 1000$, $\tau_{\min} = 0.01$, and $Q = 20$.

3.2. MMAS Pheromone. After each cycle, only one ant performs the pheromone update. The value range of pheromone for each ant is restricted to $[\tau_{\min}, \tau_{\max}]$; when the

Table 1: Student evaluation indicators and weights.

Index number	Evaluating indicator	Weight	Score
Zb1	Abide by discipline and strict management	0.06	6
Zb2	Knowledge mastering and ability training	0.08	8
Zb3	Develop thinking and stimulate interest	0.07	7
Zb4	Prepare lessons well and be a teacher	0.04	4
Zb5	Clear views and concepts	0.15	5
Zb6	Select content and update knowledge	0.15	15
Zb7	With practice, examples are appropriate	0.08	8
Zb8	Focused and organized	0.07	7
Zb9	Teach students according to their aptitude and pay attention to inspiration	0.12	12
Zb10	The language is vivid and easy to understand	0.08	8

Table 2: Distance matrix $D^{(0)}$.

	G_1^0	G_2^0	G_3^0	G_4^0	G_5^0	G_6^0	G_7^0	G_8^0	G_9^0	G_{10}^0
G_1^0	0									
G_2^0	0.261	0								
G_3^0	0.44	0.32	0							
G_4^0	0.47	0.37	0.31	0						
G_5^0	0.59	0.44	0.21	0.44	0					
G_6^0	1.05	0.87	0.65	0.78	0.52	0				
G_7^0	0.54	0.71	0.94	0.82	1.07	1.52	0			
G_8^0	0.44	0.43	0.94	0.35	0.67	1.06	0.55	0		
G_9^0	0.44	0.31	0.25	0.27	0.45	0.78	0.84	0.39	0	
G_{10}^0	1.54	1.79	1.56	1.67	1.5	0.97	2.42	2.05	1.72	0

value of pheromone $\tau > \tau_{\max}$, $\tau = \tau_{\max}$ and vice versa; when the value of pheromone $\tau < \tau_{\min}$, $\tau = \tau_{\min}$.

4. Application of Cluster Analysis

4.1. Data Preparation. Each evaluation index in the teaching quality evaluation system is determined by using different evaluation indexes, weights, and percentages occupied by each evaluation system according to the teaching purpose and teaching effect of art performance courses. Taking our teaching quality evaluation system as an example, the evaluation system is mainly based on student evaluation and combined with other assessments to give the final evaluation results. Here, the student evaluation data is used as an example to study the role of cluster analysis. The indicators and weights of student evaluation are listed in Table 1.

4.2. Cluster Analysis Process

(1) Considering each teacher as a sample as a cluster $G_1^0 = \{X_1\}, G_2^0 = \{X_2\}, G_3^0 = \{X_3\}, G_4^0 = \{X_4\}, G_5^0 = \{X_5\}, G_6^0 = \{X_6\}, G_7^0 = \{X_7\}, G_8^0 = \{X_8\}, G_9^0 = \{X_9\}, G_{10}^0 = \{X_{10}\}$, the distance matrix V was calculated as follows: $d_f = \sqrt{\sum (x_i - x_j)^2}$. The results of the calculation are listed in Table 2.

(2) The smallest element in $D^{(0)}$ is 0.22, and G_3^0 is the distance between G_5^0 and the new cluster: $G_1^1 = \{X_1\}, G_2^1 = \{X_2\}, G_3^1 = \{X_3\} G_4^1 = \{X_4\}, G_5^1 = \{X_4\} G_6^1 = \{X_6\}, G_7^1 = \{X_7\}, G_8^1 = \{X_8\} G_9^1 = \{X_9\}, G_{10}^1 = \{X_{10}\}$. The combined distance matrix $D^{(1)}$ is calculated until all clusters are completely combined.

(3) For the clustering results, these 10 teachers can be divided into 7 iterative processes:

The first iteration process is the teacher numbered {20103, 20105}.
The second iteration process joins the teacher numbered {20109}.
In the third iteration process, teachers numbered {20104}{20101,20102} were added respectively.
The fourth iteration process joins teachers with numbers {20101, 20102, 20104}.
The fifth iteration process joins the teacher numbered {20108}.
The sixth iteration process joins the teacher numbered {20106}.
The seventh iteration process joins the teacher numbered {20107}.
The eighth iteration process joins the teacher numbered {20110}.

4.3. Clustering Result Tree. The clustering result tree of nearest distance clustering was used for students' evaluation scores of teaching, as shown in Figure 2, and the clustering of each observation can be clearly seen from the tree result graph with an obvious clustering effect. The above comparison results show that the algorithm has different degrees of improvement in the evaluation indexes in each dataset compared with the traditional algorithm, and the algorithm outperforms other improved algorithms in terms of overall effect compared with other algorithms.

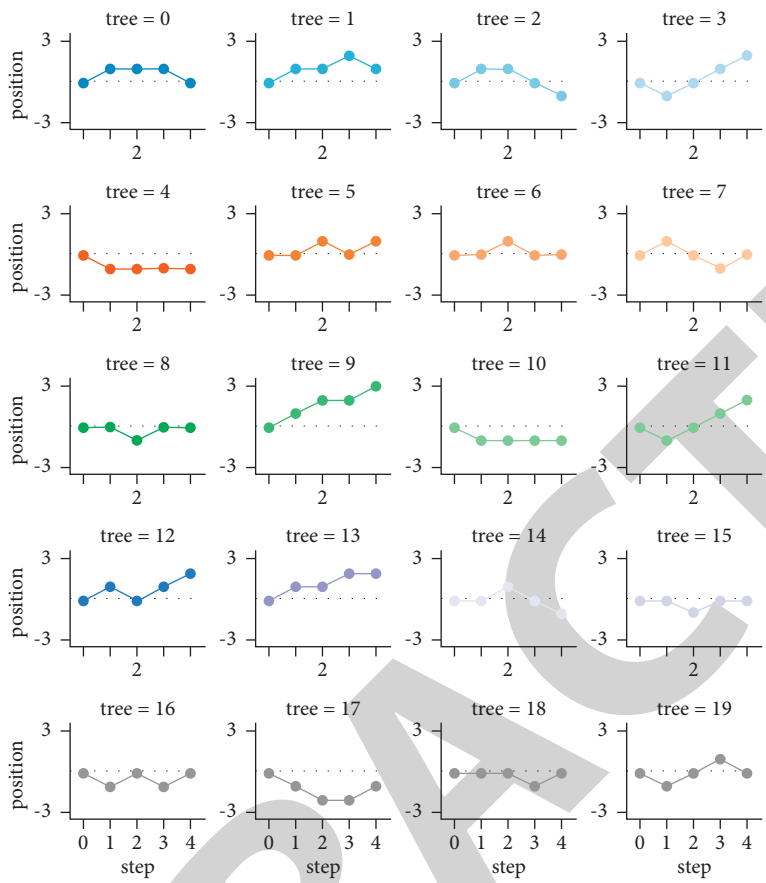

Figure 2: Tree results.

5. Research Objects and Methods

5.1. A Comparative Study on the Curriculum of Art Majors in Four Universities. Course structure mainly refers to the components of the curriculum system, and there are two main types of course structure systems in general: one is set up according to public courses, professional courses, and practical courses; the other is set up according to general education course modules, professional course modules, and practical course modules. Although the names are different, the actual classification is the same. General courses mainly correspond to the ideological quality requirements of talent training requirements, foreign languages, computers, physical education, and other basic knowledge and work ability requirements, general courses are basically divided into two kinds of compulsory courses and elective courses, compulsory courses are the courses that students must complete in school, and elective courses are based on their own interests and strengths, in the courses offered by the school for elective, to meet a certain number of credits; the second category is the professional courses. At present, the curriculum system of professional courses mainly includes two kinds of compulsory courses and elective courses, which may vary from school to school; the third category is practical courses, which are narrowly and broadly defined. The narrowly defined practical courses mainly refer to practical activities conducted outside the classroom, while the broadly defined practical courses include both in-class and out-of-class practical activities. In the talent training program, the practical course is a narrow concept in the curriculum structure, and some refer to it as a comprehensive practical course.

As can be seen from Table 3, the credit requirements of art majors in sports colleges are basically between 150 and 160, and the ratio of course structure is basically general courses : specialized courses : practical courses = 3 : 6 : 1, and the total number of credit hours required is between 2500 and 2600. For example, the total credit hours of Jilin Institute of Physical Education are 2200, which does not include the 21 credit hours of practical courses. According to the algorithm of talent training program, the practical courses should meet at least 300 credit hours; the credit requirement of Hebei Institute of Physical Education is 165 credits, of which 10 are bonus credits. For example, Shanghai Institute of Sports has set up a separate module of innovation and entrepreneurship and a module of discipline foundation course; Shandong Institute of Sports has set up a separate module of second class and innovation and entrepreneurship; Jilin Institute of Sports has divided the practical education courses into basic practical courses, social practical courses and practical courses of discipline competition, and so on. Jilin College of Physical Education has divided the practical education courses into three categories, including basic practical courses, social practical courses, and

Table 3: List of the curriculum structure of the four sports colleges and universities where the art majors are located.

Name of institution	Total credits	Total class hours	General course			Professional courses			Practice course		
			Credit	Class hours	Proportion (%)	Credit	Class hours	Proportion (%)	Credit	Class hours	Proportion (%)
Shanghai Institute of Physical Education	152	2574	41	127	27.1	89	1921	58..4	22	647	14.2
Shandong Sports Institute	174	2417	44	741	30.74	90	1426	58.21	18	287	11.3
Hebei Institute of Physical Education	158	1542	42	1023	41.84	91	1472	46.74	22	310	12.3
Jilin Institute of Physical Education	156	2410	43	714	28.12	93	1247	58.32	23	0	13.4

Table 4: Curriculum settings of general courses in the majors of aerobics in the four colleges and universities.

School name	Credits of compulsory courses	Elective course credits	Compulsory characteristic courses	Same or similar courses
Shanghai Institute of Physical Education	34 (9 doors)	8	English is offered for four semesters	Mao Zedong thought and socialism with Chinese characteristics, introduction to marxism, outline of modern Chinese history, situation and policy, ideological and moral cultivation and legal basis, college English, computer foundation, college students' mental health education, and college students' career planning
Shandong Sports Institute	43 (11 doors)	5	College physical education, and college Chinese	
Jilin Institute of Physical Education	44.5 (12 doors)	6 (at least 3 doors)	Basic education courses of military theory, employment guidance, and entrepreneurship	
Hebei Institute of Physical Education	57 (21 doors)	12	College Chinese, military theory, calligraphy, Putonghua, pedagogy, psychology, principles of physical education, sports injury and massage, Hebei folk Wushu, track and field, gymnastics, and football	

discipline competition practical courses, which further refine the types of practical courses [19, 20].

From Tables 3 and 4, it can be seen that the general education courses in several colleges and universities have the following characteristics: First, in the curriculum setting, the credits of general education courses in Shandong Institute of Physical Education, Jilin Institute of Physical Education, and Shanghai Institute of Physical Education are between 40 and 40. Under the setting of the total credits of the course, the proportion of physical education courses is 30% or less; while the general courses in our school of physical education account for 41.8%, such as computer application foundation, College English, college students' mental health education, and other courses; third, in the characteristic general courses, Shanghai Institute of Physical Education pays more attention to students' foreign language ability, English courses are completed for four semesters, and other schools start 2–3 semesters; Shandong Institute of Physical Education has made college physical education and college Chinese as general required courses for dance performance majors; Hebei Institute of Physical Education has made pedagogy, psychology, principles of physical education, sports injury and massage, Hebei folk martial arts, track and field, soccer, and gymnastics as public courses.

It can be seen from Tables 4 and 5 that the professional curriculum settings of the four colleges and universities mainly show the following characteristics: first, the proportion of professional course credits in the total credits is between 50% and 60%. The ratio of required courses to elective courses in Shanghai Institute of Physical Education is 1 : 1, the ratio of required courses to required courses in Shandong Institute of Physical Education and Hebei Institute of Physical Education is close to 2.5 : 1, the ratio of compulsory courses and elective courses of Jilin Institute of Physical Education is 4 : 5. Second, in the professional compulsory courses, there are four courses that are the same. The foundation and practice of dance choreography, the basic theory of performance, the basic theory of music, and the basic training of ballet are all set in the professional compulsory courses of the four schools. The credits are set differently. For example, the Jilin Institute of Physical Education is setting 4 credits for these four courses, and it is basically set to take classes in the first three semesters. The ballet training foundation of Shanghai Institute of Physical Education has three semesters, a total of 7.5 credits, the other three courses are set to 2 credits like Shandong Institute of Physical Education and Hebei Institute of Physical Education, and the credit hours are 32, which are basically offered

Table 5: List of professional courses for aerobics in four colleges and universities.

School name	Credits of compulsory courses	Elective course credits	Compulsory characteristic courses	Compulsory same or similar courses
Shanghai Institute of Physical Education	42.5 (13)	45.7	Introduction to art, history of Chinese and foreign dance, basis of literary script creation, stage creation and practice, multimedia creativity and production, sports anatomy, basic ballet training (7.5), dance choreography techniques (7.5), modern dance, and impromptu choreography	
Shandong Sports Institute	64 (10)	26	Introduction to art, pedagogy, educational psychology, basic gymnastics, special physical training, special theory, and practice (42 credits)	Basic dance choreography and practice, basic performance theory, basic music theory, and basic ballet training
Jilin Institute of Physical Education	40 (16)	54	Performing makeup art and practice, artistic repertoire performance and design, Chinese folk dance, modern dance, introduction to sports art, scientific basis of sports human body, rhythmic gymnastics/hip-hop dance, aerobics, yoga, sports dance, cheerleading, artistic innovation, and entrepreneurship methods	
Hebei Institute of Physical Education	54 (9)	23	Introduction to art, special theory and practice (30 credits), sports training, sports physiology, and sports anatomy	

Table 6: Comparison of practical projects and credits.

School name	Practical projects and credits
Shanghai Institute of Physical Education	Comprehensive practice projects mainly include military theory and training (2 credits), internship (6 credits), art practice (4 credits), professional skill practice and test (2 credits), basic physical fitness test (2 credits), and graduation thesis (6 credits)
Shandong Sports Institute	Entrance education and military training, professional skill training practice (6 credits), professional practice (6 credits), and graduation thesis (6 credits)
Jilin Institute of Physical Education	Practical education courses mainly include basic practical courses (19 credits), social practical courses (2 credits). basic practical courses include entrance education and military training (1.5 credits), educational practice (10.5 credits), graduation design (5 credits), graduation education (0.5 credits), and physical fitness test (1.5 credits); social practice courses include five compulsory items: social investigation activities, labor and public welfare activities, campus cultural activities, social work and skill training. participation in subject competitions, and sports competitions and community activities can replace optional courses
Hebei Institute of Physical Education	Second class (2 credits), internship (10 credits), thesis (6 credits), and public welfare labor (2 credits)

in 1–3 semesters. Third, the characteristic professional curriculum of the four schools is reflected in that the curriculum of Shanghai Institute of Physical Education emphasizes dance foundation and choreography. Cultivating specialized talents in different professional directions is for students to have a deeper understanding of their majors and master professional knowledge; Jilin College of Physical Education focuses on cultivating students' professional knowledge by making several dance types as compulsory courses and giving more choices. In order to give full play to students' initiative, major improvement courses and minor improvement courses are offered as elective courses to meet the needs of students in different professional directions when recruiting students for further studies.

From Tables 3 and 6, it can be seen that the credits of practical courses in the four schools are arranged at about 20 points, which mainly include practical activities such as professional practice, graduation thesis, entrance education, and military training. The physical education courses of some colleges and universities do not specify the specific hours of activities. For example, the practical courses of Jilin Institute of physical education are not included in the total hours of the courses. In the curriculum system of Shandong Institute of Physical Education, according to the different elective courses that students take, the credits of practical courses in class, extracurricular, on-campus, and off-campus add up to the total credits of 50.6–65.3%. It is stipulated in the graduation conditions that the credits of the compulsory

Table 7: Scores of teachers and students' evaluation of the theoretical content of physical training.

Theoretical content	Teacher score	Sort	Student score	Sort
The origin and development of body training	3.2	20	3.6	21
Classification and characteristics of physical training	3.56	20	3.65	20
Significance and function of body training	3.96	18	3.54	18
Body training terminology	4.37	8	3.83	19
Thoughts, principles, and methods of creating physical training	4.47	6	4.62	2
Contents and methods of physical training	4.48	6	4.62	2
Contents and methods of form training	4.21	12	4.32	6

practice link account for the credits required for graduation of 53.8%.

5.2. Evaluation of the Performance Courses. With the rise of sports and arts performance majors, society has put forward new requirements for the talent training of sports and arts performance programs, and the reform of physical training course content has drawn the attention of experts and scholars in sports and arts performance programs. Curriculum content reform has always been one of the core of teaching reform, which involves what kind of knowledge and ability students can learn in the future [20, 21]. Educational production with quality but not quantity is inefficient educational production, and educational production with quantity but not quality is inferior educational production [22, 23]. Teachers and students, as an integral part of the curriculum, are the creators and subjects of the curriculum, and their needs for the content of physical training courses are an important basis for the content of the curriculum.

It can be seen from Table 7 that although there are considerable differences in the number of teachers and students surveyed, the judgment of the importance of theoretical knowledge content is the same in many places. In addition, the content and methods of temperament training, the structure and implementation of physical fitness training courses, the content and methods of teaching physical fitness training courses, sports injuries and prevention of physical fitness training, and scientific exercise methods of physical fitness training were ranked first. It is evident that teachers and students pay equal attention to the teaching, creation, and fitness instruction of physical training, and theoretical knowledge that is closely integrated with practice.

The content of theoretical knowledge that teachers and students rated as low at the same time are as follows: the origin and development of physical training, classification and characteristics, the meaning and function of physical training, the self-supervision system of physical training, and the formulation and implementation of physical training exercise prescriptions. It can be seen that teachers and students do not pay enough attention to theoretical content that is not clearly integrated with technical content.

This is an indispensable theoretical knowledge for physical training and fitness guidance, organizational teaching, and scientific research. Students do not rate this kind of knowledge highly. In the future, middle school students should pay attention to improving their theoretical cultivation.

From Table 8, it can be seen that the evaluations of both teachers and students are higher than the average: physical dexterity practice teachers score 4.58, ranking third; students score 4.62, ranking first; ballet body training teachers score 4.46, ranking seventh; students ranked 6th with a score of 4.41, ranked 7th with a score of 4.46 for basic bar training, ranked 2nd with a score of 4.51 for students, ranked 6th with a score of 4.50 for flexibility training, ranked 7th with a score of 4.40 for students, and ranked 7th with a score of physical coordination The value is 4.38, ranking 9th, and the student score is 4.50, ranking 3rd.

Some technical components were rated significantly higher by students than by teachers. For example, teachers of yoga form training ranked 17th with a score of 4.00 and students ranked 3rd with a score of 4.50; teachers of muscle conditioning exercises using equipment ranked 24th with a score of 3.83 and students ranked 3rd with a score of 4.50. As can be seen, there is a tendency for students to catch up.

Some technical content teachers' evaluation scores were significantly higher than students' evaluation scores. For example, the basic posture teacher's score was 4.54, ranking 4th, the student's score was 4.00, ranking 23rd, the basic posture exercise teacher's score was 4.62, ranking 2nd, and the student's score was 4.12, ranking 19th., and basic posture exercises and other content training repeated a lot and felt relatively boring, so students did not rate these contents highly.

From the evaluation of teachers and students' knowledge of physical training techniques, we can see that both teachers and students pay more attention to physical fitness and some traditional technical contents, teachers pay more attention to basic physical training than students, and students prefer the trendy contents.

In the context of promoting quality education, innovative education, and deepening education reform across the country, the importance of ability has been pushed to a new level. Capability is a multilevel complex, and various measures must be taken to strengthen capability development. Since the formation of ability has two essential characteristics of phase and continuity, this requires that in the whole

Table 8: Scores of teachers and students' evaluation of physical training technical content.

Technical content	Teacher score	Sort	Student score	Sort
Basic posture	4.54	4	4	23
Basic position exercise	4.62	2	4.12	19
Smile and eyes	2.33	29	2.55	29
Basic steps	4	17	4.01	22
Swing and winding	4.63	1	4.25	9
Bouncing and moving center of gravity	3.47	27	3.29	28
Torso bending and waves	4.25	12	4.03	21
Basic dance and balance exercises	4.23	13	4.31	11
Swivel exercise	4.54	12	4.03	8
Jumping practice	4	17	3.58	8

learning process, not only should we pay attention to the guiding ideology that runs through the cultivation of students' ability as the core, but also at different teaching stages, according to the actual situation of the students, combined with each other. Some courses focus on the cultivation of students' abilities.

6. Conclusions

In this study, a mathematical model of the teacher was established using graph theory to transform the evaluation process into a bipartite graph model and fully utilize the ant colony algorithm for memory capacity, mastery of prior knowledge, adaptability, and collaboration. Moving back and forth between the two sets of partial graphs completed the evaluation of the teacher teaching process. In addition, the maximal and minimal pheromone strategies were applied in the original ant colony algorithm; the robustness of the algorithm itself was enhanced by making full use of the memory capacity and the necessary prior knowledge mastery in solving the teacher teaching evaluation problem. The investigation and research on the development and cultivation status of art students in physical dance are conducive to the timely identification of problems and deficiencies in the cultivation of physical dance majors, the promotion of healthy and benign development of physical dance, and the perfect integration of physical education and art education in schools.

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 declare that they have no conflicts of interest.

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Retraction

Retracted: Simulation of Film and Television Transmission Path Based on Ant Colony Optimization Algorithm

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] X. Zhao, "Simulation of Film and Television Transmission Path Based on Ant Colony Optimization Algorithm," *Security and Communication Networks*, vol. 2022, Article ID 2826527, 11 pages, 2022.

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Research Article

Simulation of Film and Television Transmission Path Based on Ant Colony Optimization Algorithm

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Aiming at the stagnation and precocity of the basic ant colony algorithm in solving the film and television transmission path problem, an ant colony optimization algorithm with forgetting factor is proposed. By adding forgetting factor to artificial ants, a new state transition formula is established, and pheromone update strategy is modified. Combined with the optimal error rate of the current solution, the state transition equation is adjusted. Due to the introduction of the forgetting factor, the new formula can be adjusted in time when the original ant colony algorithm calculation falls into the local optimal solution, and the selection and updation of the next node are carried out according to the new state transition scheme. Pheromone, which can be used to reduce the optimal value error, improves the tracking ability of the optimal value, modifies the path evaluation model, and calculates the probability of each path to the current optimal solution. The simulation results of the film transmission path problem (FTPP) example show that the improved algorithm takes less time and the result of path optimization is better.

1. Introduction

The film transmission path problem (FTPP) is a typical combinatorial optimization problem [1]. Based on the demand for timeliness and universality of film and television communication, many works hope to achieve the most coverage in the shortest time [2]. For the individual audience of film and television media, FTPP is a typical combination optimization problem [3]. How to coordinate and plan the optimal propagation path is the most important problem for FTPP. Solving the optimal solution given by FTPP is also the best way to reduce the consumption of resources in film and television transmission [4]. Ant colony optimization (ACO) is a kind of smart search algorithm. Ant colony algorithm has artificial intelligence based on collective behavior of decentralized self-organizing system [5, 6]. Ant colony algorithm has good advantages in solving optimal path of FTPP. The search process adopts a distributed computing method, and multiple individuals perform parallel computing at the same time, which greatly improves the computing power and operating efficiency of the algorithm. However, it is easy to fall into local convergence [7]. The ant colony algorithm has the characteristics of positive feedback. The pheromone in the environment at the initial moment is exactly the same, and the ants complete the construction of the solution almost in a random way. These solutions are bound to have advantages and disadvantages. When the pheromone is updated, the ant colony algorithm leaves more pheromone on the path passed by the better solution, and more pheromone attracts more ants. This positive feedback process rapidly expands the initial difference and guides the whole system to evolve toward the optimal solution. Although positive feedback makes the algorithm have a better convergence speed, if the optimal solution obtained by the algorithm at the beginning is a suboptimal solution, the positive feedback will make the suboptimal solution quickly dominate, making the algorithm fall into a local optimum, and it is difficult to jump out of the local area. optimal. For the improvement of ant colony

algorithm, there are more famous elite strategy ant system and optimal sorting ant system. [8, 9]. In the grid environment, the balanced job scheduling is improved to optimize the water distribution system and solve the weapon target allocation problem [10].

Aiming at the stagnation behavior and premature convergence of basic ant colony algorithm in solving FTPP [11, 12], this paper constructs an ant colony optimization algorithm including forgetting factor, named as the forgetting factor ant colony optimization (FFACO) [13]. FFACO optimizes the transition formula and pheromone update rules. It shortens the time cost of propagating receptor conversion [14], maximizes the leading role of the current optimal solution, speeds up the convergence speed, and avoids the generation of local solutions [11]. The experimental simulation results confirm that FFACO can track the optimal solution by changing the forgetting factor [15], thus avoiding the accumulation of errors and improving the efficiency of the algorithm [16].

2. Ant Colony Optimization Algorithm

2.1. ACO Mathematical Model. When ants are looking for food, they make path selection by considering the length of the path and the pheromone on the path (the ant will release pheromone on the path it travels, and other ants can perceive this pheromone and prefer to choose a pheromone with a higher concentration). The pheromone concentration on the path is low at the beginning, and the ants will preferentially choose the shorter path according to the length of the path. With the passage of time, the pheromone on each path gradually accumulates and increases, and the shorter the path, the more ants walk through, the more pheromone remains on the path, and the more ants choose to take the path, thus forming a positive feedback. Eventually, the ants find an optimal path from the nest to the food source.

In the basic ant colony algorithm, ants mainly depend on the distance between nodes when choosing a path, that is, the shorter the distance, the greater the probability of the path being selected, and the longer the distance, the smaller the probability of the path being selected. As some subpaths in the global optimal path (subpaths are paths formed by the connection of any two nodes) may be longer, the probability of this subpath being selected is small, causing the ants to miss the subpaths that constitute the potential global optimal solution.

The FTPP problem is the problem of dissemination of works to various dissemination points. The location of the works can be regarded as the source of dissemination, and each receiving point can be regarded as a point in the dissemination path. Therefore, the FTTP problem is how to cover each dissemination point from the source of dissemination. The problem of the shortest path at the same time, which is represented by a fully weighted digraph $G = (V, A, d)$, variable $V = \{1, 2, \ldots, n\}$ is the node set, where n is the number of nodes, $A = \{(i, j) | (i, j) \in V * V\}$ is an arc set, D is a set of arcs $arc(i, j)$.The purpose of FTPP is to find the shortest path when each recipient visits only once. When an ant is looking for food, it releases pheromones on the path it travels, other ants can be attracted by the pheromone, and as more and more ants pass the path, more pheromones will deposit on this path, thereby attracting more ants to continue to choose this path [17, 18]. Therefore, according to this principle, ants search for the shortest path from the starting point to the food source and back again, the calculation logic is shown in the upper part of Figure 1, while the lower part of Figure 1 is the content of the time series algorithm for auxiliary calculation, This paper mainly introduces the optimal planning situation of ants in the time of searching paths and verifies the results of their shortest path selection.

The formal definition of basic ACO is provided below. In the initial stage of the algorithm, each ant is randomly placed on a node position:

$$p_{ij}^{l} = \begin{cases} \dfrac{\tau_{ij}^{\alpha}(t) \cdot \eta_{ij}^{\beta}(t)}{\sum_{k \notin tabu_k} \tau_{ik}^{\alpha}(t) \cdot \eta_{ik}^{\beta}(t)}, j \notin tabu_k \\ 0, j \in tabu_k \end{cases}, \tag{1}$$

$$\tau_{ij}(t+s) = (1-\rho)\tau_{ij}(t) + \Delta\tau_{ij}, \rho \in (0, 1), \tag{2}$$

α is an information heuristic factor, which determines the relative influence of pheromones, β is the expected heuristic factor, which indicates the relative importance of the expected value, and reflects the influence of path length on ant movement, ρ is a pheromone residue coefficient. $\tau_{ij}(t)$ is the trace amount of the pheromone at time ρ on $arc(i, j)$. The pheromone on the path will evaporate step by step. After time ρ, the track strength is updated according to equation (2):

$$\Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k}. \tag{3}$$

In formula (3), $\Delta\tau_{ij}^{k}$ is the number of k ants in time t and time $t + s$ the amount of trace material (pheromones in real ants) per unit length, m is the number of ants. A pheromone updating model of ant circulation system is shown in formula (4), where Q is the total length of the scene path, and L_k is the length of the path traveled by the kth ant:

$$\Delta\tau_{ij}^{k} = \begin{cases} \dfrac{Q}{L_k}, arc(i, j) \text{belongs to best tour} \\ 0, \text{otherwise} \end{cases}. \tag{4}$$

2.2. ACO Algorithm Flow. The implementation steps of ACO algorithm are as follows:

(1) In the initialization stage, the basic parameters required by the algorithm are generated $\alpha, \beta, \rho, \beta$ is the number of ants. N_c is the number of iterations. value between nodes $arc(i, j)$ initial pheromone concentration path $\tau_{ij}(0) = A$.

(2) According to the probability calculated by formula (1), ants choose the position of the next node to move and update the corresponding $tabu_k$;

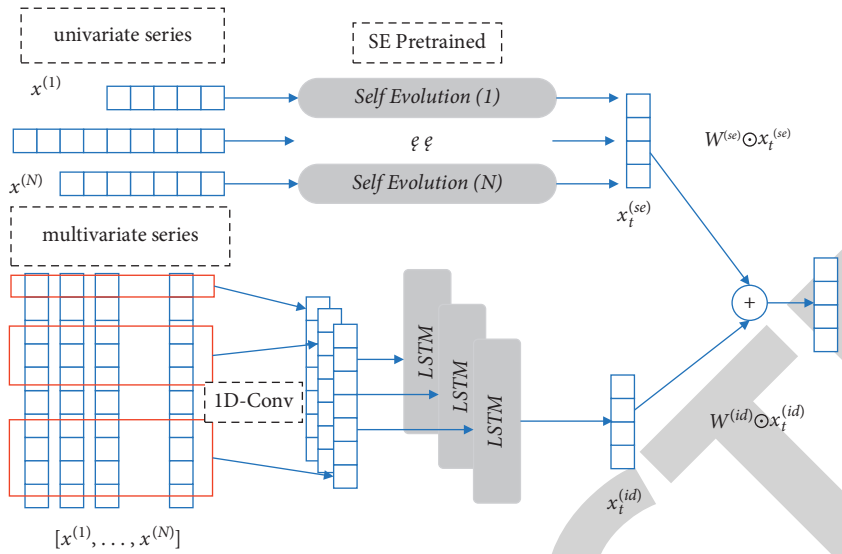

Figure 1: Ant colony time series diagram.

(3) When ants complete a tour, they record the minimum cost value of the path they pass. If the value is better than the current optimal solution, the optimal solution is updated, in the case of confirming that the number of nodes passed through is the same, compare the value of the total length of the path that the ants often travel throughout the entire journey. The number of ants is m and select the next node according to the probability function to complete the propagation.

(4) The number of pheromones left by ants on each path is calculated.

(5) Repeat steps (3) to (4) until all ants have completed the whole propagation.

(6) A cycle is completed, the pheromone concentration values deposited on the path are updated according to formulas (2)–(4).

(7) When the algorithm reaches the specified termination times or reaches the set optimal error rate, the algorithm ends running and outputs the optimal solution.

The specific process is shown in Figure 2:

3. Improved Ant Colony Optimization Algorithm

3.1. Forgetting Factor Regulation Strategy. To solve the problems of local optimization, search stagnation, and slow initial convergence of traditional ant colony algorithm [19], the improved optimization algorithm adopts the local update method of adjusting pheromone and the global update strategy of pheromone, the forgetting factor can be used to determine the data distinction in the pheromone update process to keep records. Ants achieve a better balance in the process of searching and strengthening [20]. This algorithm has been tested on the known data [21]. When the error is large, prefer a smaller forgetting factor to improve tracking sensitivity [22]. When the calculation error is small, the forgetting factor with a large value is preferentially selected to delay the memory scale and improve the recognition accuracy [23]. When comparing the forgetting factor, the number of times the forgetting factor is used is the main comparison standard. If the times are the same, the recorded path length is used as the comparison standard.

The core of the film and television communication problem is to solve the problem of correlation between nodes [24], as shown in Figure 3 for the node topology.

3.2. Initial Pheromone Setting. When the traditional ant colony algorithm constructs the solution, the pseudorandom factor is set as a constant, but the size of the pseudorandom factor often has a certain influence on the diversity and convergence speed of the algorithm in the early stage of the algorithm. When the pseudorandom factor is small, the ants will choose roulette with a high probability to construct the next solution, which increases the possibility of ants exploring unknown paths, thereby expanding the search space in the early stage and increasing the diversity of understanding, but it reduces the algorithmic complexity [25]. Conversely, when the pseudorandom factor is large, the ants will select the path according to the pseudorandom ratio with a large probability. Although the convergence speed of the algorithm is improved to a certain extent, if the previous ants fail to find a better path, due to the accumulation of pheromone, it will cause certain interference to the subsequent ant path construction, making the algorithm fall into a local optimum.

In the ant system (as) algorithm, the initial pheromone concentration is evenly distributed. In the initial stage of the algorithm, the ants conduct a large number of blind search and generate many invalid paths, resulting in inaccurate pheromone concentration update on the path, weakening the heuristic significance of pheromone indicating path. This

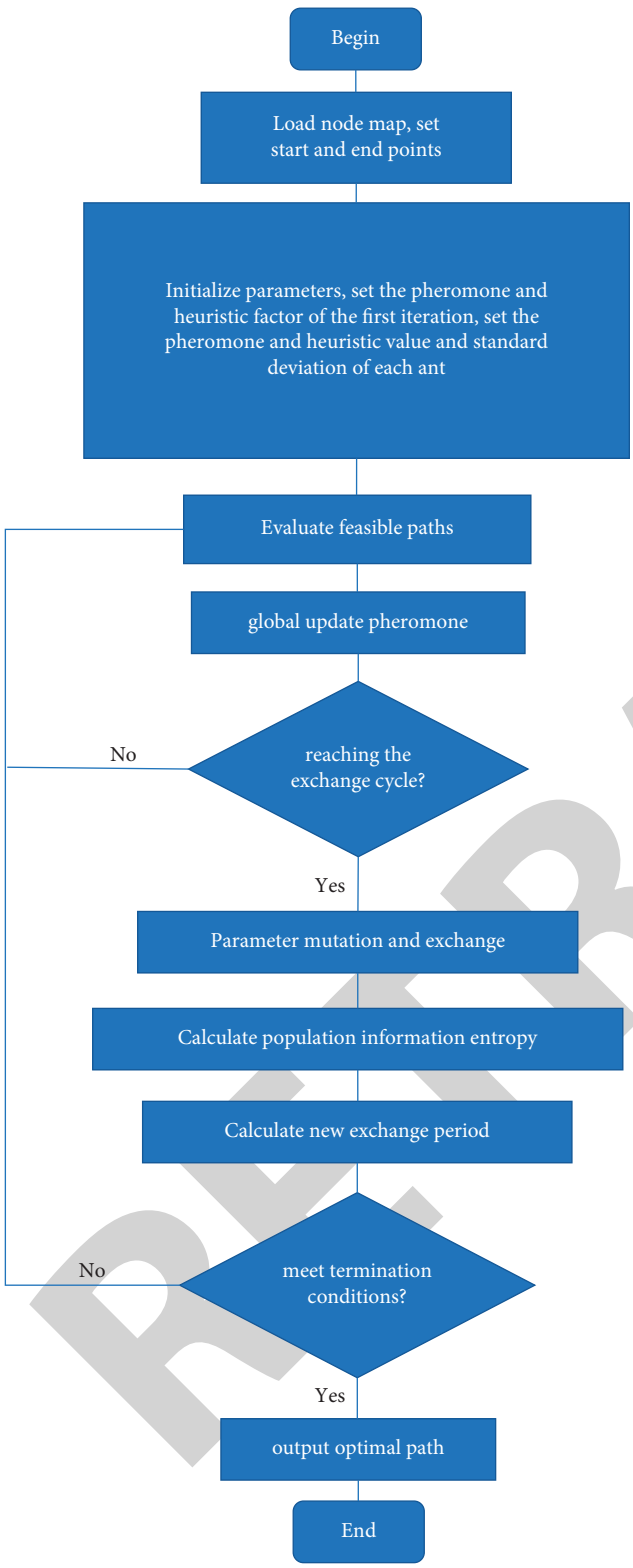

Figure 2: Ant colony algorithm execution flow chart.

problem not only makes the initial search time of the algorithm longer, but also due to the error of pheromone concentration updating, the search path falls into local optimum, which affects the performance of the algorithm. Inspired by the forgetting algorithm, this paper reduces the value of forgetting factor in the early stage, that is, being able to find correlations from unknown things and refining the rules is the sign of true intelligence. Firstly, ant colony algorithm is used to find the information of suboptimal path, and then the value of forgetting factor is added to search for path information. A is the initial test pheromone matrix in the following equation:

$$A = \tau_0 * \text{ones}(N, N), \tag{5}$$

$$\tau_{ij}(0) = \begin{cases} \dfrac{1/d_{ij}}{l_N/n}, i \neq j \\ 0, \text{other} \end{cases}. \tag{6}$$

The initial pheromone is generated by $\tau_{ij}(0)$ in equation (6). It can realize the reasonable control of the initial pheromone concentration in the initial stage of the algorithm, which is conducive to the ability of ant colony algorithm to avoid choosing the path with high pheromone concentration when solving the FTPP and makes the algorithm easy to fall into the local optimal solution. It avoids searching on the nonoptimal path due to too many pheromones in ant colony system, and the pheromone concentration is too low to search for a long time. If the pheromone concentration is too low, subsequent ants will not choose this path. Even if this path may be the optimal path, it will be ignored because the pheromone concentration is too low.

3.3. Improved State Transition Strategy. Inspired by an improved distribution estimation algorithm, a forgetting factor is introduced to change the state transition rule of basic ant colony algorithm. When $E_{lp} \leq E_0$, according to formula (1), when each ant is sorted by the basic ant colony algorithm, the probability of moving to the next receptor node is given $E_{lp} > E_0$. The probability of ant selecting the next receptor node needs to be adjusted, and the probability of ant transferring to the next node needs to be adjusted $P^k_{\text{new}\,ij}(t)$ as shown in the following equation:

$$P^k_{\text{new}\,ij}(t) = \begin{cases} \text{argmax}_{j \in \text{allowed}_k}\left([\tau_{il}]^\alpha \cdot [\eta_{il}]^\beta \cdot \lambda\right), E_{lp} > E_0 \\ P^k_{ij}(t), \text{other} \end{cases}, \tag{7}$$

$$E_{lp} = \left|\frac{c_b - c_*}{c_*}\right|, \tag{8}$$

$$\lambda = 1 - E_{lp}. \tag{9}$$

As shown in equation (8), E_{lp} represents the optimal value error obtained by the second propagation of lp. E_{lp} represents the difference between the result and the ideal value of the algorithm. The smaller the size of E_{lp}, the better the algorithm performance. c_b represents the optimal value of the algorithm, and c_b is the ideal value. $\lambda \in (0,1]$ comes from equation (9). If the optimal value of an ideal is unknown in the beginning, c_* can be represented by l_N as shown in the following equation:

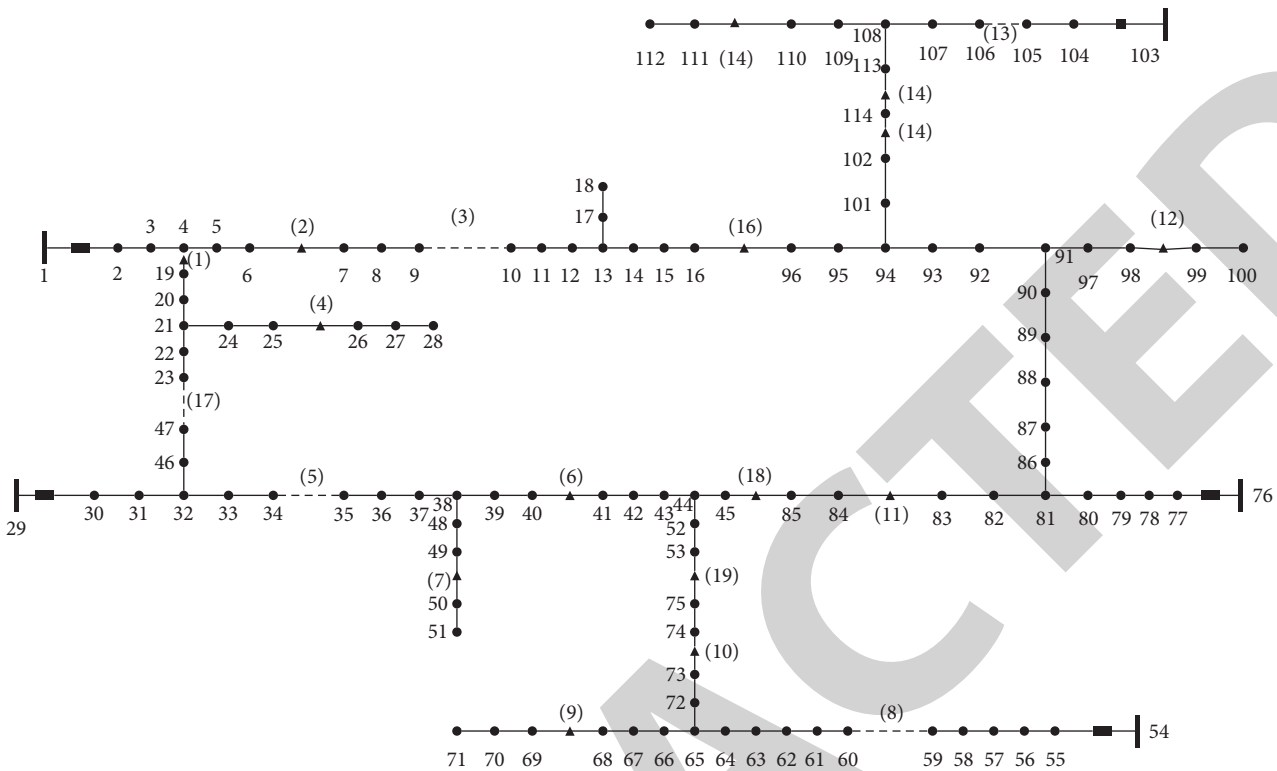

Figure 3: Video distribution node topology.

$$E_0 = \left|\frac{c_b - l_N}{l_N}\right|. \tag{10}$$

3.4. Improved Pheromone Updating Strategy. In the initial stage of the algorithm, the pheromone on all solutions is the same. With the advancement of the algorithm, the pheromone on the optimal solution will gradually increase, and the algorithm will gradually converge. But in the ant algorithm, ants always rely on the feedback information of other ants to reinforce learning without considering their own experience accumulation. Such blind obedience can easily lead to premature maturity and stagnation.

The updating rule of pheromone of each ant path is shown in equation (11). The initial path is constructed by the nearest neighbor method, first determine the current departure origin, search for the nearest nodes that have not been visited and repeat in turn, and finally return to the departure origin, then calculate τ_0. In order to avoid the misleading effect of the global pheromone update strategy on the behavior of ants in the basic ant colony algorithm, the receptor node i and node j of τ_{ij} will be updated in time to improve the effective use of existing new information.

In order to enhance the feedback information of each optimal path to each ant, a new global pheromone-updating rule is proposed based on the traditional ant week model and elite strategy ant system. The rule can make full use of different information λ. Equation (12) is to add pheromones to the global optimal path:

$$\tau_{ij}(t+1) = (1-\rho)\cdot\tau_{ij}(t) + (1-\lambda)\cdot\tau_0, \lambda\epsilon(0,1), \tag{11}$$

$$\tau_{ij}(t+n) = \rho\cdot\tau_{ij}(t) + (1-\lambda)\Delta\tau_{ij}(t) + \lambda\left(\frac{1.}{L_{\text{best}}(n+1)}\right), \lambda\epsilon(0,1). \tag{12}$$

First, FFACO, like the basic ant colony algorithm, updates the pheromone on the connection path on each receptor node after each iteration. After each iteration, the path contribution degree of the subpaths in the current global optimal path is judged. If the value of the path contribution degree is greater than the given threshold, it is determined as the optimal path, and the pheromone is updated again. The improved pheromone update strategy can increase the probability of the subpaths that constitute the potential optimal solution being selected and improve the convergence speed of the algorithm. At the same time, in order to speed up the algorithm's departure from the regional optimal solution, a local optimization method can be introduced to increase the randomness of the algorithm and the diversity of search results. If the path after mutation is better than the path before mutation, use the path after mutation to perform incremental update of subsequent pheromone; otherwise, continue to use the path before mutation to perform incremental update of subsequent pheromone. The realization process of mutation is shown in Figure 4. Two different nodes are randomly selected from the propagation path, the nodes between the two nodes are exchanged, and the mutation path is finally obtained.

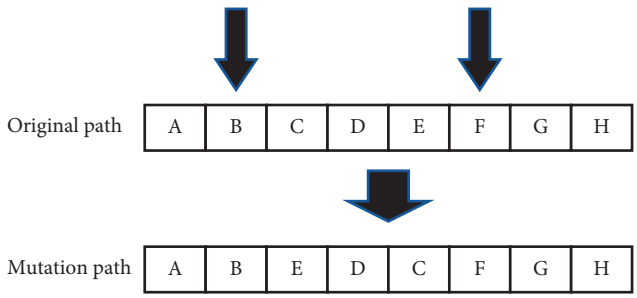

Figure 4: Ant colony propagation mutation process.

Because if the algorithm falls into the local optimal situation and deviates from the global optimal goal, the ants that follow the pheromone through the secondary path will get wrong path information, so when this situation occurs, the introduction of breeding mutation can make the original local. When the optimal situation is broken, the ants will recalculate the optimal solution to achieve the global optimal effect.

4. Experimental Environment and Results

4.1. Environment Experiment Setup. To analyze the performance of the improved algorithm, simulated annealing (SA), genetic algorithm (GA), particle swarm optimization (PSO), and ACO algorithms were tested on four different FTPP cases: chn31 test case and att48 test case datasets. The geographic coordinates of important nodes are recorded, and the ST70 and eil76 test cases, respectively, record the location and coordinate information of nodes. The SA, GA, PSO, ACO, and FFACO algorithms are applied to the four test cases, respectively. The simulation software MATLAB7 uses Intel(R) core(TM) i7-12700 CPU@4.90 GHz 12 cores and 12g running memory to conduct simulation experiments. The implementation of the algorithm will be introduced in detail below.

4.2. Algorithm Parameter Configuration

4.2.1. Parameter Configuration of SA. In the basic version of the simulated annealing algorithm, the initial temperature of SA is 120, the termination temperature is 1, and the cooling coefficient is 0.99. The operators applied to the exchange of propagating receptor nodes are shown in Table 1. The nodes that have been swapped are shown in bold in the table, and the maximum number of iterations is 200.

4.2.2. Parameter Configuration of Genetic Algorithm. The population size of genetic algorithm is 100 individuals. Starting from the nodes randomly selected by each individual, the nearest neighbor heuristic algorithm is used to generate the initial population. In the case of mutation, one individual is randomly selected from the population, and the mutation operation is carried out according to the relevant probability. In the case of recombination, the maximum algebra is 200.

Table 1: Two node random exchange operators.

2	**6**	8	**7**	5	3	1	9	4
2	**7**	8	**6**	5	3	1	9	4

4.2.3. Parameter Configuration of Particle Swarm Optimization Algorithm. The population size of particle swarm optimization algorithm is 100. The particle position is randomly initialized and the optimal path is searched circularly. Each particle searches the space separately; they remember the optimal solution they have found, and they also know the optimal solution currently found by the entire particle swarm. By calculating the population fitness value, the current optimal and the historical optimal values are updated. Combined with the cross-mutation operation, when the length of the new path is less than the historical optimal value, the update is accepted. In the case of crossover and mutation of each individual in the intermediate population, set the maximum number of evolutions to be 200.

4.2.4. Parameter Configuration of ACO Algorithm. The parameters of ACO algorithm are initialized to $\alpha = 1$, $\beta = 2$, $Q = 10$, $\rho = 0.2$, $m = 10$ and $N_c = 200$. The maximum number of iterations is 200, m is the number of ants, n is the number of nodes in this algorithm, α is the importance factor of the pheromone, β is represents the important factor of heuristic function, ρ is represents the pheromone residue coefficient.

4.2.5. Parameter Configuration of FFACO Algorithm. The parameters of FFACO algorithm are initialized as follows: $\alpha = 1$, $\beta = 2$, $m = 10$, $\lambda = 0.1$, $\rho = 0.1$, and $N_c = 200\circ$. N_c is the maximum number of iterations and its value is 200, α is important factors representing pheromones, β represents the important factor of heuristic function, m is the number of ants, λ is the forgetting factor, n is the number of nodes in the FTPP problem, and ρ represents the pheromone residue coefficient.

4.3. Experimental Results. By testing the time-consumption and the global optimal solution of the four data sets of TSPLIB, the superiority of the FFACO algorithm is fully demonstrated. In order to make the results more readable and easy to compare, the design of the five algorithms described (SA, GA, PSO, PSO, and FFACO) is as follows: each algorithm is tested on four public test cases. The average solution, the optimal solution, the worst solution, and the deviation rate from the known optimal solution is recorded from the results of 30 experiments. The simulation results of the four datasets are shown in Table 2, and the best known solution (BKS) of each test case is shown in Table 3. The number shown in the BKS row of Table 3 is the number of nodes of the best-known solution obtained by the four test cases in each algorithm environment, that is, the maximum number of nodes.

Table 2 shows the calculation results of each algorithm. The first column shows the various test cases, in ascending order of problem size; where the mean deviation of the

Table 2: Experimental calculation results.

Test cases	Algorithm	Avg	Dev (%)	Best	Dev (%)	Worst	Dev (%)
Chn31	SA	16988.515	10.480	15509.798	0.864	18590.447	20.898
	GA	15840.574	3.015	15380.515	0.023	17216.769	11.964
	PSO	16176.277	4.198	15380.515	0.023	17171.998	11.673
	ACO	15831.075	2.953	15601.920	1.463	16169.094	5.151
	FFACO	**15505.948**	**0.839**	**15380.515**	**0.023**	**15890.953**	**3.342**
Att48	SA	43947.775	21.101	39670.780	18.343	51922.190	54.890
	GA	40414.146	20.560	35879.259	7.032	45812.567	36.664
	PSO	41542.136	23.925	37802.644	12.770	44898.418	33.937
	ACO	36049.283	7.539	35002.329	4.416	36713.262	9.520
	FFACO	**34155.483**	**1.890**	**33600.561**	**0.234**	**34994.793**	**4.394**
St70	SA	1506.879	123.241	1320.669	95.655	1667.052	146.971
	GA	1189.746	76.259	1031.540	52.821	1417.894	110.058
	PSO	1241.762	83.965	1021.708	51.364	1391.826	106.196
	ACO	1310.852	94.200	1288.044	90.821	1330.420	97.099
	FFACO	**699.366**	**3.610**	**681.755**	**1.001**	**740.408**	**9.690**
Eil76	SA	1528.475	184.103	1392.716	158.869	1674.280	211.204
	GA	1144.966	112.819	983.099	82.732	1264.024	134.949
	PSO	969.793	80.259	862.578	60.330	1058.072	96.668
	ACO	576.657	7.185	565.447	5.143	585.340	8.799
	FFACO	**569.427**	**5.842**	**555.003**	**0.929**	**587.595**	**9.218**

Table 3: Optimal solution of benchmark example.

Test cases	Chn31	Att48	St70	Eil76
BKS	15377	33522	675	538

second solution and its second column are the mean deviation of the second solution, the best and worst solutions were calculated in this way from 30 obtained from the results of the runs. Only the first 200 evolution results of the algorithm are taken for each run, The change trend of the subsequent operation is similar to that of the first 200 times, and the change is relatively gentle. The calculation results of each algorithm show its true value and deviation from the optimal value. The best value results for each dataset in the table are shown in bold. Due to the introduction of the forgetting factor, the FFACO algorithm reduces the situation of falling into the local optimum during the execution process and can calculate the global optimum faster.

For the test case of chn31, the results of FFACO are very good. For the propagation case of 48 nodes, FFACO can still find the closest optimal solution (dev. 0.234%), while the deviation rate of SA, GA, PSO, and ACO optimal solutions is much higher than that of FFACO, the average and worst solutions are the bias is also much higher than FFACO.

Overall, FFACO performed the best in all of the above test cases over 200 evolutions of the optimal solution. Among the 12 optimization results in Table 3, 11 are FFACO, and the improved algorithm greatly improves the performance of the ant colony algorithm. For test cases with different problem sizes, SA, GA, and PSO require a large number of iterations to optimize the optimal path, which is the main reason why their performance is inferior to FFACO. For small problems, ACO and FFACO have significant differences in mean solution deviation, optimal solution deviation, and worst solution deviation. As the problem size increases, the results of ACO and FFACO become better than other procedures. The advantage of ACO is that it can get better results with each iteration and generate new solutions based on the learned data, but FFACO has better performance than ant colony algorithm in training optimal and mean values. Computational results show that the proposed improvement is effective for TSP and compared with SA, GA, PSO, and ACO.

4.4. Result Analysis. In order to enhance the comparison of the ability of solving the optimal solution and analyze the effectiveness of the algorithm in this paper, the evolutionary trajectory of the optimal solution of SA, GA, PSO, ACO algorithm, and the algorithm proposed in this paper are compared. The experimental results are shown in Figures 5(a)–5(d). It can be seen from the above that both the improved algorithm and ACO algorithm can quickly approach the optimal solution at the initial stage of iteration, while SA, GA, and PSO algorithms are obviously behind them. Moreover, the improved algorithm can still further optimize the optimal solution when the ACO is in a stagnant state. It shows its good tracking ability to the optimal solution. It can be seen from Figure 5(d) that the improved algorithm can quickly approach the optimal solution when solving the eil76 test case, and the evolution curve of the optimal solution of other algorithms is obviously different from that of other algorithms.

From the perspective of the problem scale, the scales of the four test cases chn31, att48, ST70, and eil76 increase in turn. In the limited number of iterations, FFACO and ACO algorithms have better solving ability, but compared with ACO algorithm, FFACO has better adaptability to solve FTPP of different scales. In terms of the quality of the solution, the proposed FFACO algorithm will update the optimal solution in each iteration. Without too much

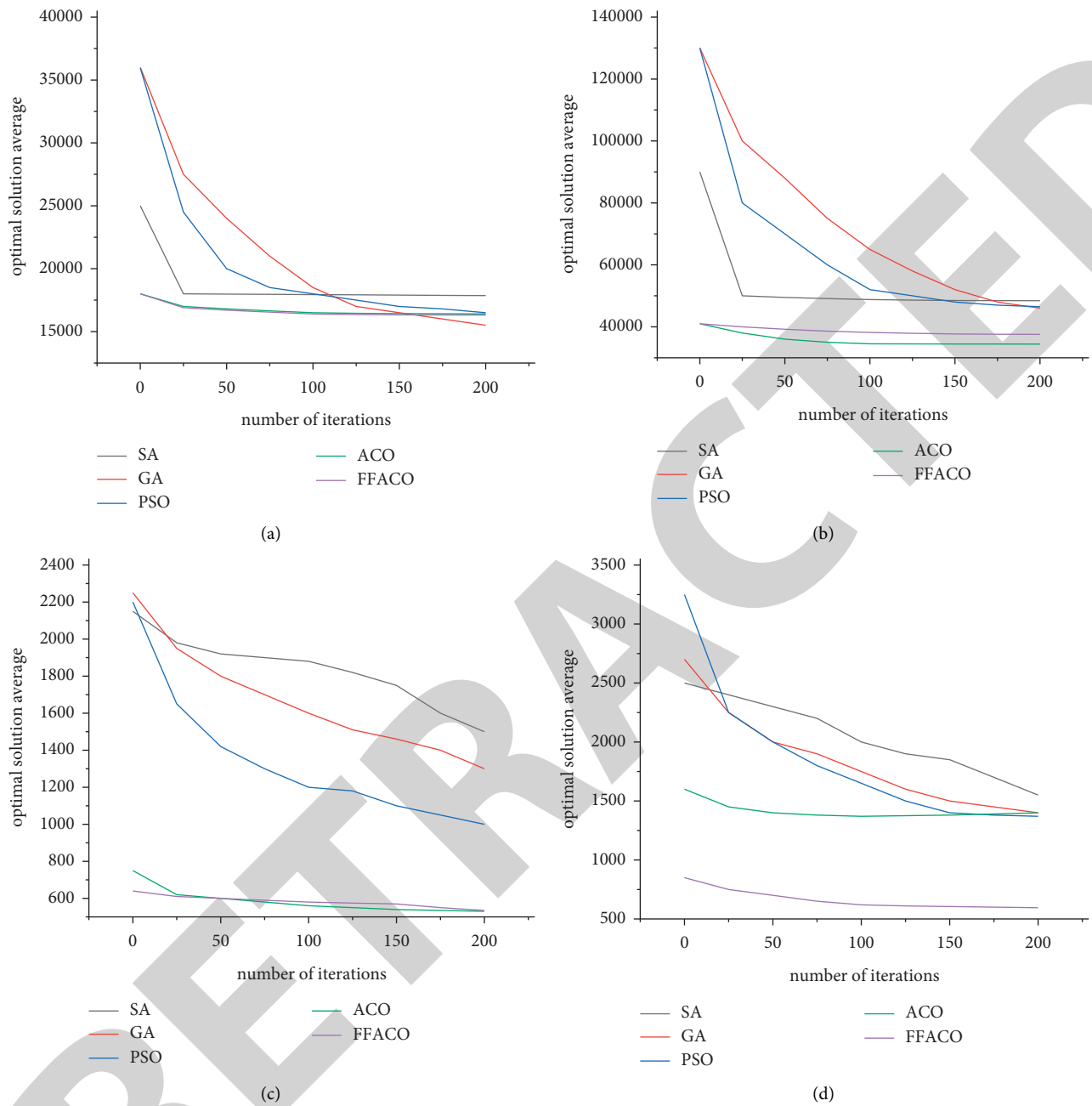

Figure 5: Algorithm iteration results comparison. (a) Evolution trajectory of optimal solution (example chn31). (b) Evolution trajectory of optimal solution (example att48). (c) Optimal solution of ST3. (d) Evolution trajectory of optimal solution (example eil76).

consideration of the size of the problem to be solved, the whole solving process is relatively stable, which effectively improves the performance of the ant colony algorithm.

It can be seen from Table 4 that the optimal solution is time consumption of the five algorithms in solving different test cases, and the bold font is the optimal value. Compared with SA, GA, and PSO algorithms, FFACO algorithm has obvious advantages in finite iteration calculation. Compared with ACO algorithm, FFACO algorithm has better ability to jump out of local optimal solution. It can track the optimal solution well and reduce the time consumption. For different test cases, the size of the required solution increases in turn, and the time for each algorithm to find the optimal solution also increases. However, FFACO algorithm is still the most time-saving in finding the optimal solution.

Figure 6 is the global optimal solution path-planning diagram of the proposed FFACO algorithm for the test case. The abscissa and ordinate shown in the figure are the description of the node location coordinates. The serial numbers 1–31 in Figure 6 are the locations of 31 nodes and their serial numbers. The roadmap here is the route that starts from node 1 and is calculated by the FFACO algorithm, passing through all nodes and returning to node 1. optimal transmission path.

Table 4: Time consumption of algorithm for optimal solution.

Test cases	Algorithm	Time (s)
Chn31	SA	5.632
	GA	5.489
	PSO	1.414
	ACO	0.807
	FFACO	**0.577**
Att48	SA	5.986
	GA	4.948
	PSO	1.686
	ACO	1.403
	FFACO	**0.955**
St70	SA	7.918
	GA	4.251
	PSO	2.139
	ACO	2.504
	FFACO	**1.497**
Eil76	SA	8.404
	GA	4.640
	PSO	2.649
	ACO	**2.868**
	FFACO	1.666

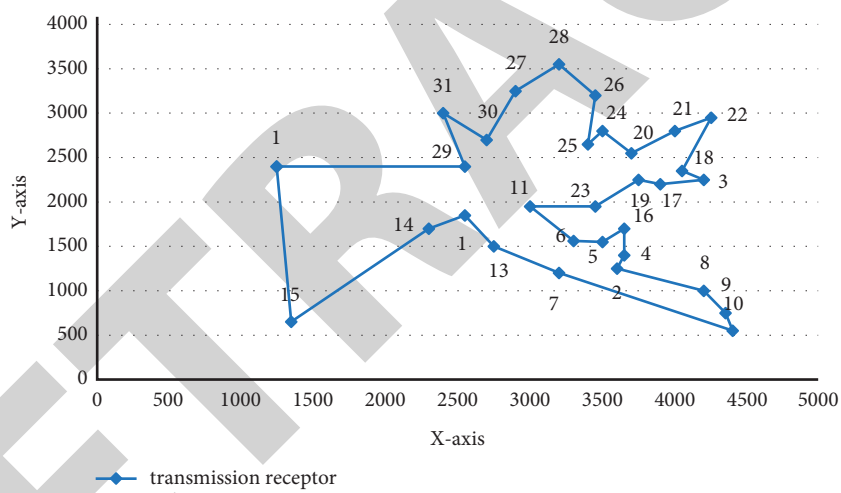

Figure 6: Global optimal solution route (example chn31).

Figure 7 is the global optimal solution path-planning diagram of the Att48 test instance, and the coordinates in the figure are the coordinate descriptions of the nodes.

The trend curve of the algorithm objective function value is shown in Figure 8. The conventional ant colony algorithm converges after more iterations and falls into the local optimum; the improved ant colony algorithm finds the global optimal solution with only a few iterations, and the convergence rate is fast, which verifies the effectiveness of the improved algorithm.

To sum up, compared with ACO algorithm, FFACO algorithm proposed in this paper has better solution ability and better adaptability to FTPP of different sizes. At the same time, in terms of 3D path planning, FFACO can record more path selection situations beyond the plane due to the introduction of the forgetting factor, which ensures that the path planning ability is still accurate in the 3D scale, which is greatly superior to the ACO algorithm. Compared with SA, GA, and PSO algorithms, FFACO algorithm significantly saves the time cost of finding the optimal solution. The algorithm proposed in this paper can effectively improve the premature stagnation phenomenon in the process of basic ant colony convergence. The whole solution process is relatively stable and effectively improves the solution quality of ant colony algorithm, which makes the improved algorithm have better robustness and convergence.

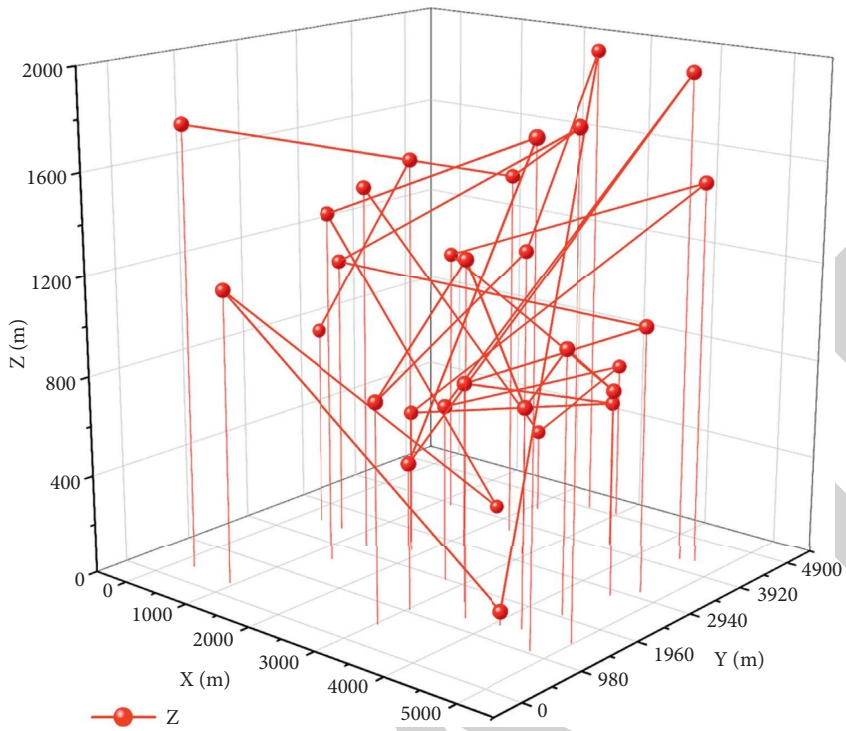

Figure 7: Global optimal solution route (example Att48).

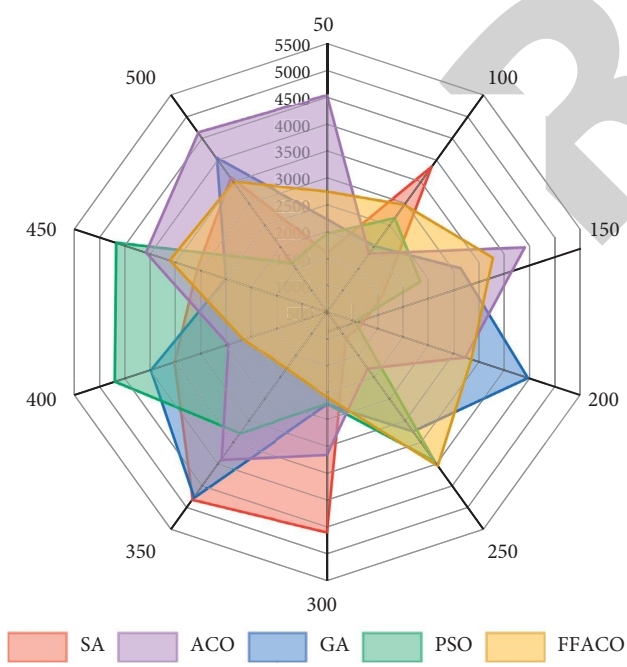

Figure 8: Algorithm comparison chart.

5. Conclusion

This paper proposes an ant colony algorithm with a forgetting factor and an improved pheromone update model. The main idea is to introduce a forgetting factor in the ants of the basic ant colony algorithm. The forgetting factor can modify the weight of the local pheromone in time and update the global pheromone. The adjustment of the forgetting factor can achieve a good tracking effect on pheromone and improve the stagnation behavior and convergence of the basic ant colony algorithm. For the film and television communication scene, the local optimal situation in the information transmission process can be well avoided, that is, the transmission effect is very good in a certain area, but the transmission of a large coverage cannot be achieved. Second, the optimized algorithm can better ensure the film and television. Information spreads the widest in the shortest time. Finally, the experimental results show that the algorithm has a good ability to find the optimal solution, and the time cost is low. Future work will focus on theoretical evaluation of the validity of the path evaluation model.

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 author declares that there are no conflicts of interest regarding this work.

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Retraction

Retracted: Discussion on Innovative Methods of Higher Teacher Education and Training Based on New Artificial Intelligence

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Deng, W. Jia, and D. Chai, "Discussion on Innovative Methods of Higher Teacher Education and Training Based on New Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 3899413, 10 pages, 2022.

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Research Article

Discussion on Innovative Methods of Higher Teacher Education and Training Based on New Artificial Intelligence

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In Chinese colleges, teachers' teaching level and proficiency in business knowledge are an important part of maintaining the knowledge system of colleges and universities. Therefore, in order to improve the teaching level of Chinese colleges and improve the knowledge reserve of college students, we should spare no effort to develop and improve the professional level of each teacher. The research on teacher training mode based on the development of teachers' teaching ability is of great significance to the development of colleges and the improvement of teaching quality. The new generation of artificial intelligence plays a pivotal role in the training of college teachers. This paper randomly selects 897 undergraduate teachers from 10 private colleges in a certain region of China who participate in higher teacher training for research. It mainly studies the application effect of several typical artificial intelligence technologies in evaluating higher teacher education and training. Specifically, the paper uses artificial intelligence as a carrier to predict the performance indicators of the three main modules involved in higher teacher education and training. The prediction results of several artificial intelligence techniques show that the support vector machine method based on immune algorithm optimization corresponds to the largest coefficient of determination and the smallest root mean square error. Therefore, it predicts the best. Furthermore, the comparison results between the predicted data and the measured data show that the artificial intelligence technology has a better prediction effect on the three module indicators. At the same time, there is a good exponential function relationship between the prediction data corresponding to the two main modules of organization and personnel.

1. Introduction

As we all know, colleges have always assumed the important functions of people training and scientific research. The cultivation of innovative talents depends on the continuous innovation of teachers. As an important factor in ensuring the quality of higher education, the teaching level of college teachers [1, 2] is directly related to the level of future education and the quality of people training. There is a close positive correlation between college teachers and higher education [3, 4]. The development of teachers is independent development and improves the intellectual support and power guarantee for the development of higher education. Furthermore, higher education is a platform for teachers to achieve independent development.

As we all know, college teachers are the first resource for educational development. A high-quality teaching team is a fundamental guarantee for improving the quality of education [5, 6]. Facing the ever-changing new situation of higher education reform [7, 8], the importance of college teacher training has become increasingly prominent. The original training system, concepts, and policies have obviously not been able to meet the needs of the development of teachers, so it is necessary to explore innovative teacher training models. This requires us to realize the transformation from the three aspects of training direction, training mode, and training method, improve the quality of training, and promote the development of teachers' teaching ability. Only by giving full play to the "hematopoietic" function of teacher training can we develop the unlimited creativity of teachers, which can promote the sustainable development of colleges.

Since the 1960s, with the continuous changes in educational theories and methods of education, significant

changes have taken place in the guiding ideology, training form, and training content of college teacher training in developed countries. Countries in Europe and the United States have carried out practical explorations of training and formed a variety of teacher training models [9, 10]. These teacher training modes mainly include curriculum-based training mode, teacher-based training mode, school-scale training mode, collaborative training mode, and network training mode. Among them, the network training mode makes full use of modern high-tech media means, such as TV courses and teaching, telephone courses and teaching, network courses and teaching, and satellite communication courses and teaching. All in all, improving teachers' independent development level through teacher training is an effective measure to promote the reform and development of higher education.

Teacher training is conducive to grasping the direction of higher education reform. The direction of higher education reform is the vane of higher education development. Teacher training can improve teachers' awareness of higher education reform and development and better grasp the direction of higher education reform. Only by continuing to adhere to the teacher training in colleges can we continue to adapt to this direction and requirements, avoid detours, and promote the timeliness and effectiveness of higher education reform. Moreover, teacher training promotes the reform goal of the connotation development of higher education.

The connotation construction with quality improvement as the main content is the value demand of higher education reform. The fundamental purpose of teacher training is to improve the teaching and educating level of teachers; that is, it refers to the level of talent training. From this perspective, teacher training is a powerful driving force for the realization of higher education reform goals. On the one hand, teacher training is conducive to improving teachers' professional ethics, enhancing their sense of mission in teaching and educating people, and guiding teachers to take cultivating talents as their primary responsibility. This requires college teachers to take teaching as their first priority and concentrate on teaching and educating people. On the other hand, teacher training is conducive to improving the teaching level of teachers.

The establishment of teacher training process in colleges needs to consider the controllability of results and the evaluability of training results. The government and colleges should formulate specific measures to strengthen the control and inspection of the training process, attach importance to the evaluation of training results, and establish a dynamic and long-term evaluation mechanism. At the same time, colleges should track and evaluate the effect of teacher training, focusing on whether teachers have good results in terms of education and teaching ability, scientific research ability, and so on.

Through the above research demerits, we get the following insights. Teacher training in colleges and universities has a long way to go, and it is necessary for colleges and universities to establish teacher teaching development centers and establish a sound teacher training system. Such policies and reforms are of great significance to the improvement of teachers' teaching ability.

2. The Practice of Artificial Intelligence Technology in Higher Teacher Education and Training

The rapid transformation of the economic development model and the "education supply-side structural reform" will have a profound impact on the teaching concepts, teaching content, and teaching models of college teachers. Furthermore, these reform measures have put forward unprecedented new requirements for the professional knowledge reserve ability and comprehensive business quality of the teaching staff.

Studies [11, 12] have shown that the training of teachers in colleges generally includes four main modules: network training, general training, school sample training, and special customized training. Figure 1 shows the four important components of teacher education and training in colleges. As shown in Figure 1, the reform and innovation of teachers based on artificial intelligence requires practitioners to understand the training content, training form, and assessment and evaluation of the target school's teaching staff. Moreover, this reform model requires that the development model of college teacher training be explored from the perspective of artificial intelligence. Among them, general training is the main component of teachers in colleges at present. Various private colleges mainly use this training mode. School training is a training model based on the general environment of school education. Special customized training is a type of training for different needs obtained according to different training needs. Network training is a new training mode. It is a way of dealing with problems based on the Internet super platform.

Figure 1 also shows that school sample training is the basis of the entire professional training. Secondly, different training contents can be carried out for different groups through special customized training.

The current mode of college teacher training in China can be summarized into four aspects. They are government-led, training organization and coordination, and university implementation. At present, China's college teacher training has made great adjustments and improvements in the structure and operation mode. The concept and connotation of "teacher development" in universities are gradually established and become clearer. Teacher development and teacher training are distinct and closely related. Teacher training pays more attention to the requirements of external organizations. Teacher development is more focused on internal self-requirements. For teachers themselves, the development of teachers is not simply the improvement of teaching skills but more concerned with the improvement of teachers' own abilities and career planning. For schools, the development of teachers aims to promote their faster integration into school development through the improvement of teachers' abilities. The ultimate goal of promoting the

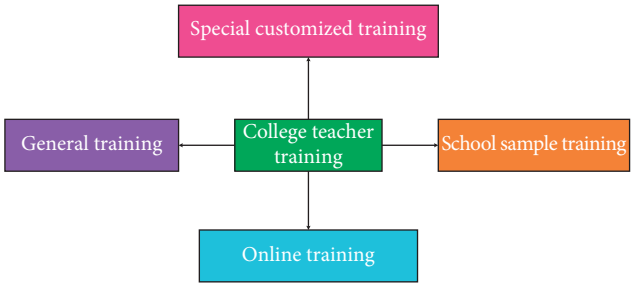

Figure 1: The main components of college teacher training.

development of the entire college education can be achieved through the individual professional development of teachers.

As the core resources of applied colleges, teachers' professional ability and literacy directly affect the quality of people training and the development potential of colleges. Therefore, it is an inevitable choice for colleges to accelerate the transformation and development of improving the effectiveness of teacher training and enhancing the professional ability and quality of teachers' teaching. However, at present, colleges, especially applied colleges, are still facing many difficulties in teacher training. These difficulties are mainly reflected in the insufficiency of training work, training guarantee, and training evaluation. Therefore, teacher education and training in colleges must also optimize training work, training guarantee, and training evaluation based on demand analysis theory.

Artificial intelligence has once again become the focus of the whole society. At present, the application of the new generation of artificial intelligence in the field of higher education is becoming more and more extensive. This requires us to actively carry out research on the training of college teachers from the perspective of artificial intelligence, analyze the new requirements and challenges faced by the training of college teachers, and propose strategies and implementation paths for the reconstruction of college teacher training. Only in this way can a new development momentum be injected into the creation of a high-quality and innovative teaching team in the new era.

Faced with the new situation and new tasks, on the basis of the successful practice of online teaching [13, 14], colleges need to continuously reform the system and mechanism of teacher training and establish new forms such as "Internet + training" and "artificial intelligence + teaching." This innovative model can promote the deep integration of next-generation artificial intelligence technology and training content.

Various application fields are inseparable from the assistance and blessing of artificial intelligence technology. The innovation and development of teacher education and training in colleges are no exception. Artificial intelligence is not limited by time and space. In addition, it has the unique advantage of being fast in replication and dissemination and can present rich effects. It can bring a new experience of intelligent "teaching" and "learning" to teachers and students and provide a wide range of intelligent tools and information service platforms for the training of college teachers. This paper introduces a general training performance evaluation system, which is referred to as the OTP model. At the same time, the paper selects 10 undergraduate colleges in a certain region of China as the research target and comprehensively understands the training situation and training performance of teachers in each college. Among them, OTP determines training requirements based on Organization, Task, and People. It determines the basic requirements of training on the basis of Organization, Task, and People. In order to quantify the evaluation indicators of higher teachers, the follow-up part of this paper mainly conducts prediction research on the performance data involved in three aspects: Organization, Task, and People.

In order to enable readers to grasp the structure of the paper, we introduce the writing ideas of the paper to everyone. First, we introduce several commonly used artificial intelligence techniques and introduce their arithmetic and application scope, respectively. Then, we take 10 undergraduate colleges in a certain region of China as the research target and conduct a systematic study on the performance evaluation indicators involved. Finally, through the introduction of artificial intelligence technology, predictive analysis and comparison are carried out.

3. Introduction to Artificial Intelligence Technology

In order to express each intelligent algorithm more conveniently, we make the following provisions in the paper. MSV stands for multidimensional support vector prediction based on immune optimization. LS-SVM-PSO stands for particle swarm optimized support vector machine. SVM stands for simple support vector machine.

3.1. Multidimensional Support Vector Prediction Based on Immune Optimization. Simple support vector machines [15, 16] reflect the functional relationship between two variables. This algorithm defines a series of calculation modes about two unknowns and achieves the prediction of the function of the dependent variable through multiple nonlinear calculation processes. In fact, a simple support vector machine can be simplified to a problem of solving the optimal solution of a function.

$$O(\varphi, \xi_i, \xi_i^*) = \frac{1}{2}\|\varphi\|^2 - D(\xi_i + \xi_i^*), \tag{1}$$

where ω is the control parameters involved in the fitting process; D represents the loss parameter that should be taken into account if miscalculation is encountered during the prediction process; O represents the number of whole datasets involved in the regression vector machine.

Researchers usually solve quadratic optimization problems involved in simple support vector machines by means of superposition multiplication. The equation form of the superposition multiplication can be expressed as (2).

$$P(\varphi, C, \phi_i, \phi_i^*, \beta_i, \beta_i^*, \gamma_i, \gamma_i^*) = \frac{1}{2}\omega \times \omega + C\sum_{i=1}^{k}(\phi_i + \phi_i^*) - \sum_{i=1}^{k}\beta_i[\phi_i + \varepsilon - y_i + g(x_i)]. \tag{2}$$

The basic kernel function of simple vector machine is the soul of the whole algorithm. This kernel function is shown in equation (3).

$$J(\lambda_i, \lambda_i^*) = -\frac{1}{2}\sum_{i,j=1}^{k}(\lambda_i - \lambda_i^*)(\lambda_j - \lambda_j^*)(y_i \cdot y_j) + \sum_{i=1}^{k}(\lambda_i - \lambda_i^*)y_i - \sum_{i=1}^{k}(\lambda_i + \lambda_i^*)\varepsilon. \tag{3}$$

The basic algorithm of multidimensional support vector regression machine is calculated as above. In addition, through the method of theoretical model derivation, we can obtain the expression of the overall multidimensional support vector machine.

$$g(y) = \sum_{i=1}^{k}(\beta_i - \beta_i^*)(y, y_i) + B, \tag{4}$$

where y represents the output value of the entire support vector machine system and B represents the intercept of the linear fit function.

It can be seen that the above analysis is aimed at the solutions of linear equations and has not been elaborated for the nonlinear situation. We introduce the concept of feature space to solve it. In the process of using feature space, we should first determine the concept of a kernel function.

$$l(y_i, y_j) = \varphi(y_i) \cdot \varphi(y_j). \tag{5}$$

In the formula, L and φ represent the mapping function of the input variable.

Traditional support vector machines are prediction algorithms set for one-dimensional variables. However, in practical applications, computational problems involving multiple variables are often encountered. This requires us to optimize the traditional algorithm so that it can better serve multivariate problems.

We address the above problem by defining the concept of loss function.

$$L(u_i) = \begin{cases} 0, & u_i < \varepsilon \\ (u_i - \varepsilon)^2, & u_i \geq \varepsilon \end{cases}, \tag{6}$$

where $\eta_i = \|\mathrm{d}_i\| = \sqrt{d_i^T d_i}; d_i^T = x_i^T - \pi^T(y_i)\alpha - B^t$; $\alpha = [\alpha^1, \cdots, \beta^N]$; $B = [B^1, \cdots, B^N]^T$; ϕ is the nonlinear mapping kernel function.

The piecewise function mentioned above can be transformed into the following form:

$$H_P(\varphi, B) = \frac{1}{2}\sum_{j=1}^{Q}\|\varphi^j\|^2 + CH(u_i), \tag{7}$$

where B and ψ represent two variables of the function vector space. Q represents the geometric size of the vector space. C represents the regression constant associated with the vector space.

By derivation of formula (8), we can get

$$H_P' = \frac{1}{2}\sum_{j=1}^{Q}\|\omega^j\|^2 + C\left(\sum_{i=1}^{n}L(u_i^k) + \frac{dL(u_i)}{du_i}\Big|_{u_i^k}\frac{(e_i^k)^T}{u_i^k}[e_i - e_i^k]\right). \tag{8}$$

In addition, the transformation from one-dimensional to multidimensional can be realized by constructing the matrix quadratic form of the above formula. Some scholars have found the mathematical relationship between multiple independent variables and dependent variables.

$$H_P'' = \frac{1}{2}\sum_{j=1}^{Q}\|\omega^j\|^2 + C\left(\sum_{i=1}^{n}L(u_i^k) + \frac{dL(u_i)}{du_i}\Big|_{u_i^k}\frac{u_i^2 - (u_i^k)^2}{2u_i^k}\right) = \frac{1}{2}\sum_{j=1}^{Q}\|\omega^j\|^2 + \frac{1}{2}\sum_{i=1}^{n}a_i u_i^2 + CT, \tag{9}$$

where $L_P''(\mathbf{W}, \mathrm{b})$ represents the second derivative of the vector space of the entire variable.

The immune system, as we know it, is a computational modality that produces irritable changes in response to changes in external stimuli [17, 18]. The animal antibody system receives the stimulation of external antigens, produces corresponding antibodies, and has a certain memory function for the unique antigens of the outside world. Similar to an animal's immune system, we can develop a computational model. In this mode, the independent variable corresponds to the antigen, and the dependent variable corresponds to the antibody. That is, one independent variable corresponds to one dependent variable.

In immune algorithm, the number of populations is a key physical quantity. In the actual operation process, the appropriate population number can control the reproduction speed of the population and increase the global optimization ability.

A typical multipeak function is used to enhance the application of the immune algorithm. The specific expression of this multimodal function can be expressed as

$$n(z) = \sum_{i=1}^{m-1}\left(100(z_{i+1} - z_i^2)^2 + (1 - z_i)^2\right). \tag{10}$$

In the calculation process, the multidimensional support vector machine needs to determine several necessary engineering parameters in advance to complete the subsequent calculation tasks. The purpose of this operation is to find the necessary time nodes required for the function to converge in the shortest possible time.

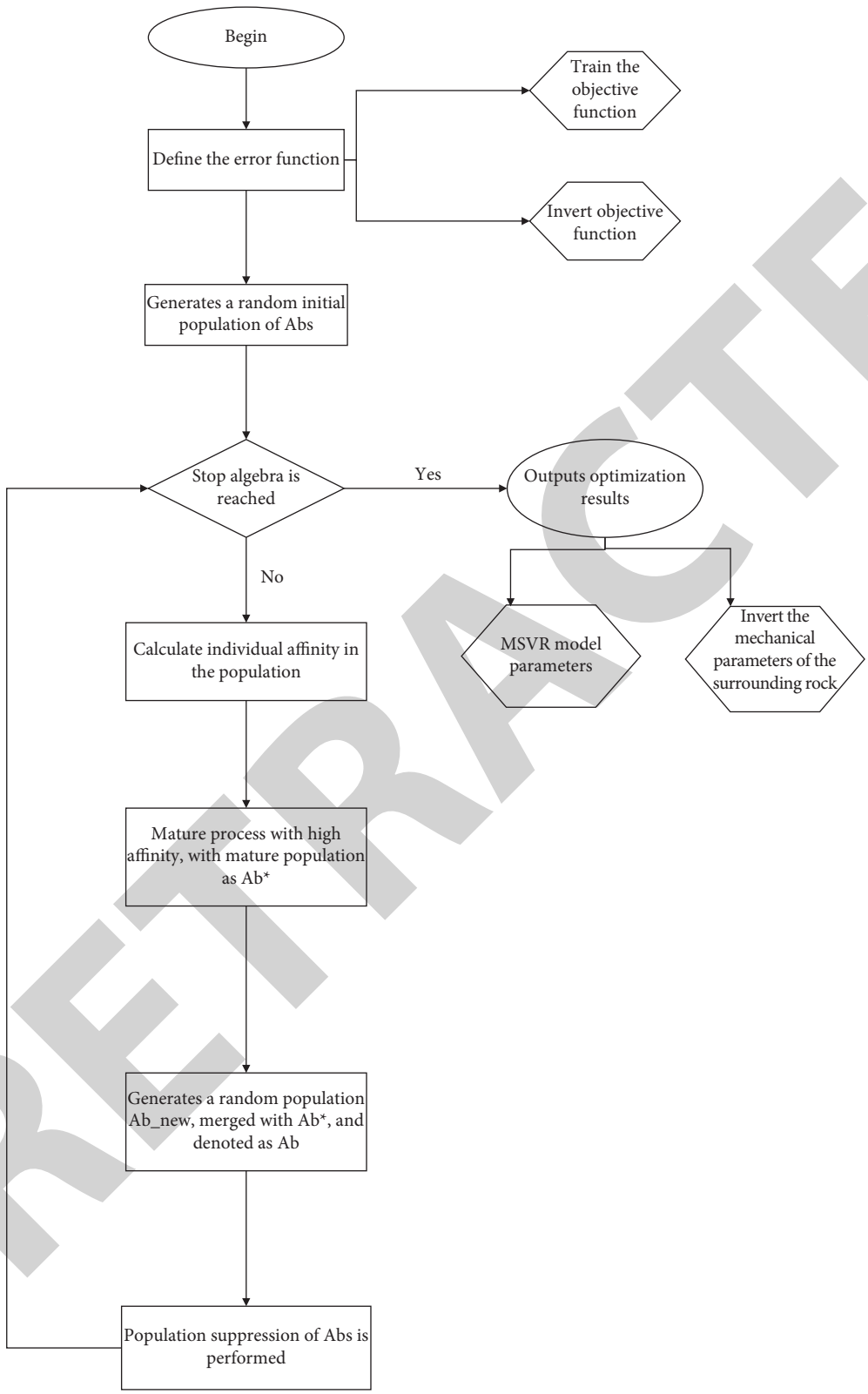

Figure 2: Computational process of multidimensional support vector machine combined immune algorithm.

During the training data phase, we use the same control function to reduce the relative error value of the overall function.

After the optimal multidimensional support vector machine model parameters are obtained through the optimization of immune algorithm or particle swarm algorithm, the calculation process of the entire artificial intelligence coupling algorithm is completed. Figure 2 shows the overall calculation process of the multidimensional support vector machine optimized by the immune algorithm.

3.2. Based on Particle Swarm-Least Squares Support Vector Machine Model. The LS-SVM algorithm is an optimization of the standard support vector machine algorithm. Its main optimization feature is the addition of equality constraints. In this way, we use the solution of the linear equation to solve the resulting solution of the inequality constraints.

The final optimization function of LS-SVM is

$$g(z) = \sum_{i=1}^{n} \xi_i \cdot K(z, z_i) + B. \tag{11}$$

In the formula, B is the bias constant; ξ_i is the Lagrange multiplier.

The kernel function selected in this paper is the Gaussian kernel function, and its expression can be expressed as follows:

$$h(z_i, z_j) = \exp\left(-\frac{\|z_i - z_j\|^2}{2\sigma^2}\right), \tag{12}$$

where z_i and z_j represent the collected value and average value of the research samples, respectively. $h(z_i, z_j)$ represents the linear distance of the sampled data point from the sampled mean z_j. This function mainly indicates the degree of dispersion of the distribution of the collected samples. That is, the function is similar to the concept of data variance. σ is the kernel width of the Gaussian kernel function.

In previous studies, we mostly choose the control parameters of the LS-SVM model empirically, and the obtained model is often not optimal. We use the particle swarm algorithm to iteratively optimize these two parameters of the LS-SVM model. This can improve the computational efficiency of the entire algorithm.

PSO [19, 20] is mainly used to simulate various social behaviors such as reproductive inversion between populations and birds looking for food. It is another form of expression for evolutionary algorithms. However, it is undeniable that it is simpler than the calculation rules of the genetic algorithm.

These particles automatically search for a single best position and a global best position according to the optimal problem solution, according to the optimization criteria found in nature.

During the calculation of PSO, we need to update the relative position and relative velocity of each calculation example in real time. In fact, we can complete the realization process of the above calculation principle through an iterative function.

$$\begin{cases} \theta_i = \omega \times \theta_i + c_1 r_1 (o_{best} - \lambda_i) + c_2 r_2 (k_{best} - \lambda_i). \\ x_i = x_{i-1} + \nu_i \end{cases} \tag{13}$$

In the formula, θi and λi represent the relationship between the speed and displacement of each particle, ω is the inertia weight, reflecting the real-time impact of the speed of the previous example on the current particle speed, and c represents the gradual learning and development of particles during the calculation process. It can be thought of as a learning process. o_{best} represents the information of the local optimal position. k_{best} represents the information of the global optimal position.

As shown in Figure 3, we can clearly identify the relationship between the computational performance of the algorithm and the computational time, that is, the number of iteration steps, as the intelligent algorithm progresses. Among them, 1–10 represent the process of 10 trials. It can be found that the sixth trial calculation takes the longest time to converge.

In the actual calculation and application process, the square sum of errors can be used as the optimal function expression for optimization of particle swarm advanced optimization

4. Practical Operation of Intelligent Algorithms in Higher Teacher Education Training

This paper randomly selects 897 teachers from grades 1 to 4 in 10 private colleges in a certain region of China who participate in higher teacher training for research [21, 22]. The sources of these sample data are mainly distributed in the following aspects. Among them, the first-year teachers account for 30%, the second-year teachers account for 25%, the third-year teachers account for 30%, and the remaining senior-year teachers account for the proportion.

Based on the three specific evaluation indicators corresponding to the OTP model, this section mainly studies the application of artificial intelligence in teacher training in colleges through the two artificial intelligence technologies introduced above. These three specific indicators mainly include three main modules: Organization, Task, and People. Among them, People is the basis of teacher training, and secondly, the Organization structure of the whole personnel can be created by arranging corresponding tasks.

In order to achieve the purpose of comparison of prediction effects, pure support vector machines are also used in this kind of research process.

The OTP mode is mainly implemented through the following steps. First of all, it is an organization-based needs analysis, which refers to the study of the needs of the organization in the development process based on various dimensions such as conditions and structure. Secondly, the training content is formulated by analyzing the knowledge and skills required to be competent for a certain job position. Finally, based on people-based demand analysis, starting

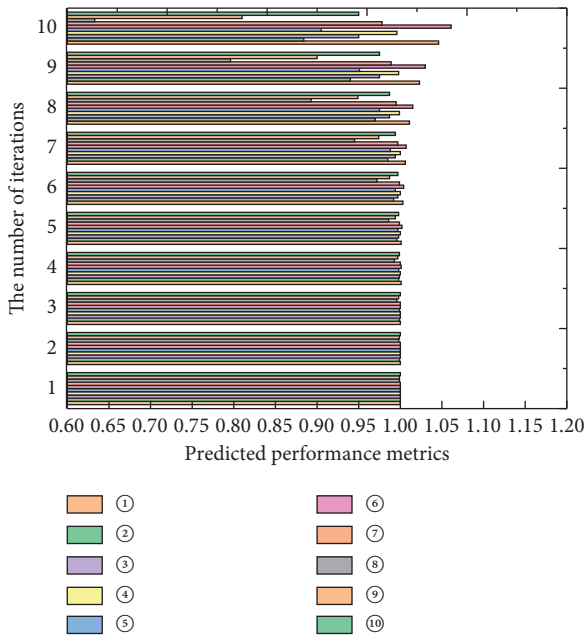

Figure 3: The math connections between the number of iterations and the prediction performance in particle swarm optimization.

Figure 4: The proportion of the main modules of the three training.

from the actual situation of people, it can design personalized training programs based on their work bases. In addition, the performance analysis model considers performance gaps to be a basic need for training. However, the performance gap is entirely due to the gap in knowledge and skills.

Figure 4 shows the percentage of performance corresponding to the three main modules of Organization, Task, and People. As shown in Figure 4, the proportions corresponding to the three aspects of Organization, Task, and People all show similar changing laws. That is, the proportion of participating in teacher training is larger, which

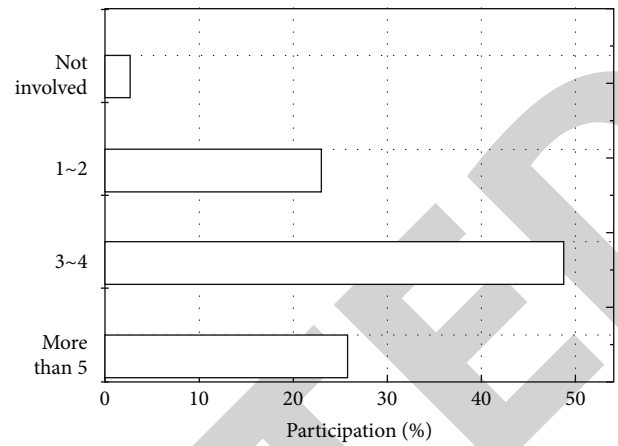

Figure 5: Percentage of teachers participating in educational training each week in the overall teacher data sample.

also shows the importance and necessity of teacher training from the side.

OTP mode [23, 24] and performance analysis mode are the more classic modes in training needs analysis. Both have great influence. The subsequent models are based on these two models. In the process of teacher training, colleges can use the OTP model and performance analysis model as a reference to optimize the training work, training guarantee, and training evaluation based on the actual situation. Only in this way can the effectiveness of teacher training be improved through targeted training. As we all know, the number of times of participating in training can roughly represent the teacher's preference for higher teacher education and training. Figure 5 shows the percentage of teachers participating in educational training each week in the overall teacher data sample. As shown in Figure 5, teachers who participated 3 to 4 times a week had the largest percentage. Its percentage is close to 50%. The corresponding proportion of more than 5 times is close to 25%. On the contrary, the proportion of not participating at one time is the smallest, which shows that college teachers attach great importance to teacher training.

Through the two coupled intelligent algorithms mentioned above, multidimensional support vector prediction based on immune optimization and based on particle swarm-least squares support vector machine model, the three specific indicators involved in higher teacher training are predicted and studied. In order to make the comparison conclusion more credible, this paper also adds the prediction research of pure support vector machine. It is well known that the squared correlation coefficient (r^2) and the root mean squared difference (RMSE) are two typical predictors [25]. Among them, the corresponding RMSE can be calculated by the following formula:

$$RMSE = \sqrt{\frac{1}{n} \times \sum_{i=1}^{n} \left| \left(y_i - x_i \right)^2 \right|}. \tag{14}$$

Table 1: Comparison of prediction performance of three big data technologies.

Artificial intelligence technology	The effect of regression analysis	
	Squared correlation coefficient (r^2)	Root mean squared difference (RMSE)
MSV	0.9238	0.2011
Based on LS-SVM-PSO	0.9821	0.1562
SVM	0.8674	0.268

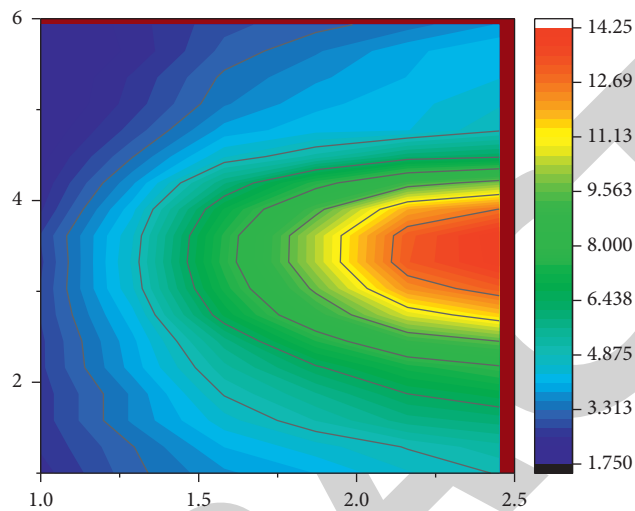

Figure 6: Predictive 3D effect display of typical intelligent algorithms.

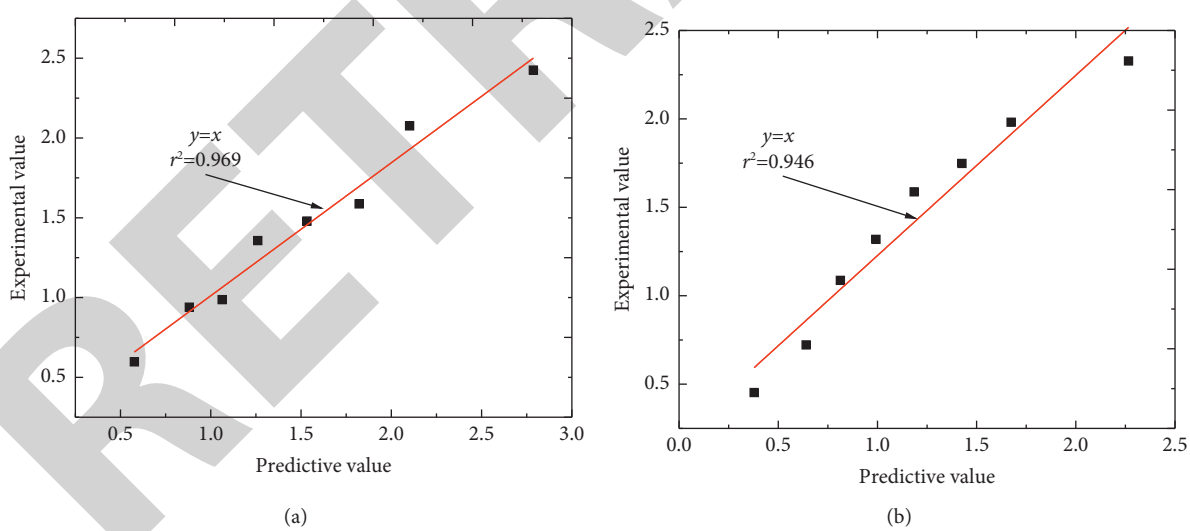

Figure 7: Mathematical correlation between measured and calculated values.

The next step is to compare the prediction effect of the artificial intelligence algorithm by comparing the coefficient of determination and the root mean square difference of the three algorithms. Table 1 shows the prediction performance of the three artificial intelligence algorithms.

It can be seen from Table 1 that the square of the correlation coefficient corresponding to LS-SVM-PSO is the largest, and the maximum value reaches 0.9821. The root mean squared difference is the smallest, and the minimum value is 0.1562. This shows that, compared with the other two algorithms, LS-SVM-PSO has the best prediction effect. The above analysis shows that LS-SVM-PSO can be used as a representative artificial intelligence technology in innovative research on higher teacher education and training.

In addition, in order to more systematically study the prediction effect of artificial intelligence technology, the two-

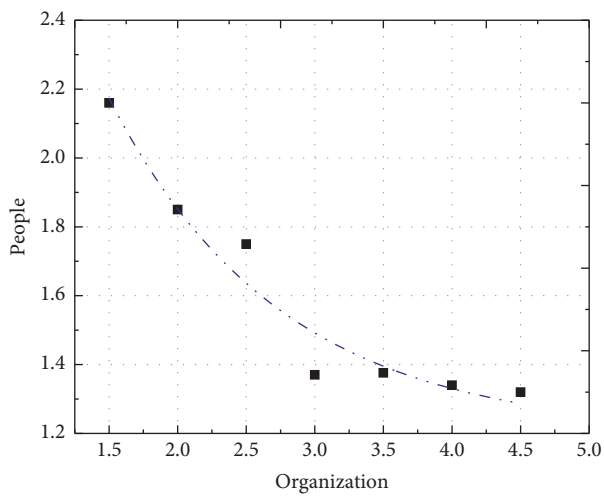

Figure 8: Data fitting relationship between organization and people.

dimensional contour cloud map of the prediction data obtained by the typical intelligent algorithms is drawn in Figure 6. As shown in Figure 6, the prediction results obtained by using artificial intelligence have good continuity. From Figure 6, we can see that the predicted data has the highest probability of appearing in the range of 2.0–2.5. On the contrary, in the range of 1.0–1.5, the probability of occurrence of predicted data is the lowest.

We show the measured data and predicted data of the four main modules involved in the training in Figure 7. It is worth noting that the prediction data is obtained based on LS-SVM-PSO. In particular, it should be pointed out that a represents the organization and b represents the people.

The functional relationship between organization and people is studied by means of data fitting, as shown in Figure 8. As shown in Figure 8, there is a certain exponential function relationship between the two.

5. Conclusion

In the new era of development, colleges are required to focus on the goals of talent training and the new needs of teachers' professional development. The paper introduces three different artificial intelligence technologies: support vector machine based on immune algorithm, support vector machine based on particle swarm optimization, and pure support vector machine. Using the above three artificial intelligence technologies, the performance data corresponding to the three main modules of Organization, Task, and People involved in higher teacher education and training were predicted and analyzed. The prediction effect shows that, for the research case introduced in this paper, LS-SVM-PSO has the best prediction effect. It can be found that the root mean square difference corresponding to LS-SVM-PSO is only 0.1562. In addition, the results of the comparison between the predicted data and the measured data show that the artificial intelligence technology has a better prediction effect on the three module indicators. Moreover, the forecast data of organizations and people exhibit a functional relationship of an exponential function.

Data Availability

The experimental data used to support the findings of this study can be obtained from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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Retraction

Retracted: Intelligent Detection and Analysis of Wearable Devices in Wushu Training

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] Y. Yi and T. Yu, "Intelligent Detection and Analysis of Wearable Devices in Wushu Training," *Security and Communication Networks*, vol. 2022, Article ID 1413905, 6 pages, 2022.

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Research Article

Intelligent Detection and Analysis of Wearable Devices in Wushu Training

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With the integration and development of artificial intelligence and medical technology, wearable intelligent technology has become an important health testing equipment in people's lives, constantly testing physical function and health. However, according to the movement standards, body indicators, and constantly changing detection indexes of athletes in the exercise process, it can effectively guide athletes to use them correctly and efficiently, which has become an important task of wearable intelligent technology. In the design mode of wearable smart devices, wearable bracelets are designed with acceleration sensors, martial arts training data are measured, and machine learning technology is used to analyze and evaluate the data. When a user uses the method, a sensor is used for collecting the data, the data are transmitted to a processing platform through low-power Bluetooth, the data are analyzed through a program, the accuracy of each action is output, and finally, a standard measurement result of a section of the boxing method is combined. This paper collects and analyzes the data of body characteristics and movement characteristics of wearable intelligent devices in Wushu training. Sensor technology and filtering technology are used to collect and filter the collected information, and better analysis data are obtained. Finally, the filtered data of Wushu are analyzed, and then, the efficiency and performance of different algorithms in Wushu training are compared. Wearable intelligent equipment collects Wushu action training data and then uses fixed threshold classification to recognize Wushu action. The results show that the method used has high accuracy.

1. Introduction

With the continuous development of the information technology industry, its manifestations in the real world are constantly changing [1]. In recent years, wearable smart devices that attract international attention are among one of them. The user can transfer the physical state of the body to the computer processing system through wearable intelligent devices and visually output it in combination with the current physical environment information of the user [2]. At present, this technology is widely used in daily life fields such as medical and healthcare, industry, and sports. Wearable technology is providing convenience for more and more industries through its advantages.

Accurate acquisition of action information is the key to measuring the effectiveness of the detection system. From the current research results, there are three ways to obtain action information. The first is based on computer vision technology, and through this, it can obtain the athlete's skill characteristics by decomposing the video according to the action and by analyzing the action according to certain standards, generally used in international competitions and large-scale competitions but not in daily training [3]. The second is based on a tracking technology, using a three-dimensional tracking technology to obtain position information, and then analyze the motion state [4]. This method makes it easy to receive interference information from the outside world but its acquisition methods are limited. The third is based on inertial sensor technology; this technology obtains motion data from different parts by wearing inertial sensors and obtains training data by analyzing the obtained data [5].

The detection system based on wearable intelligent equipment can be carried around to reasonably analyze the body load through the physical condition of athletes and contact with the upper and lower conditions; it can make targeted suggestions to athletes according to the predesigned martial arts action state, which is the mainstream martial arts detection system at present [6]. This paper briefly discusses the acquisition of athletes' data and data processing [7]. Literature [8] develops a sensor which is applied to the data acquisition scene of the Wushu boxing ring. The pressure sensor on the body protector is used to test the phase data so that the referee can score. The advantage is that it can improve the accuracy of related tests and competition scoring. It can communicate with other devices in fusion, which can further improve the accuracy of motion data. Literature [9] has strong subjectivity in view of the artificial evaluation method, which is not easy to popularize. Combining wearable computing technology with traditional Wushu training, a wearable Wushu action quantitative evaluation system is designed and developed, which takes the wrist guard as the hardware carrier and combines it with the machine learning method. Through the analysis of sports data, the error analysis model of martial arts movements is established, and then, the neural network quantitative evaluation model of martial arts movements is established. The neural network is trained by an expert scoring strategy to realize the quantitative evaluation of martial arts training.

2. Research on Wushu Training

In the process of daily martial arts training, athletes often harm their bodies because of irregular training movements or unreasonable training intensity. However, these conditions are generally not noticed by athletes or coaches at the beginning, knowing that years of training will eventually lead to long-term injuries. Therefore, it has become a trend to reduce training injuries through real-time monitoring of athletes in the daily martial arts training process.

2.1. Injury Studies. In the daily training of Wushu, because of the competitive nature of the sport itself, injuries of athletes in daily training are inevitable, and because of the rapid development of sports at present, all industries are advancing in a stronger and faster direction, so most athletes face high-intensity and high-load training, which will greatly stimulate their physical potential and improve their training effect if they are within the bearing range of athletes. However, if the injury caused by improper training to athletes is ignored, it might lead to serious lifelong disorders [10]. Through research studies, it is found that quite a number of martial arts athletes have serious knee joint injuries, among which the average incidence of male athletes is 93.0%, and the average incidence of female sports injuries is 85.4%. We must pay attention to such a high incidence of injuries.

2.2. Training Promotion. In the process of martial arts training, mastering the appropriate rhythm and the standard of movements are two major ways to improve the training effect. In general martial arts training, some athletes excessively pursue difficult training and ignore the rhythm of martial arts movements. Grasping the appropriate routine rhythm can enlarge the advantages of martial arts athletes themselves, and saving their own physical strength can also bring strong visual impact and inner shock to the audience [11]. Second, the most important point in the process of Wushu training is the standard of movements. Wushu has a long history in China, and every Wushu action has been studied repeatedly by predecessors. Through formal Wushu training, sports injuries can be effectively avoided and athletes' levels can be improved in a limited time.

3. Motion Detection and Recognition

3.1. Acceleration Characteristics of Human Motion. Movement is a complex process, and the completion of an action needs to mobilize various parts of the body, and the acceleration of each part is different. The acceleration of the same action will also be affected by different time and place environments. According to the research of Bhattacatya et al. and Cappozzo, we find that the acceleration presents a certain range law under different motion states, as shown in Table 1. According to the research of Carlijn et al. [12], in the daily movement of the human body, the frequency of acceleration component in the vertical direction is higher than that in the horizontal direction in most cases, which can also be seen from Table 1.

3.2. Data Processing Based on Acceleration Sensor. The general process of human motion recognition can be divided into the following modules, as shown in Figure 1. In the recognition process, the acceleration data generated by different motion parts of users are first collected. The second is data preprocessing, which mainly deals with data errors to reduce the influence of error values on data. Third, according to a certain feature extraction algorithm, the processed data are extracted to meet a certain standard feature vector. Fourth, feature vectors are selected, and the related characteristics of user motion patterns are represented by these vectors. These vectors will be used to identify classifications and compare templates [13, 14].

Usually, there is a training module in template training, in which the reference model for recognition is trained. The data used for comparison in the reference model is usually the feature vector that has passed the data selection. These vectors are stored in the memory, and after a certain training algorithm, the characteristics of this template are enlarged to become a certain standard, thus becoming a reference model in this module [15].

By matching the feature vector of the input sample and the feature vector of the saved reference model, the similarity between the sample data and the template data is obtained, and the result is output.

3.2.1. Data Acquisition Module. As the basic module of the system, the data acquisition module plays an important role in the whole system, and almost all the subsequent

Table 1: Table of motion parameters.

Motion state	Ankle	Back	Head
Running	3.0~12.0 g	0.9~5.0 g	0.8~4.0 g
Walk	−0.3~0.8 g	−0.3~0.4 g	−0.2 g~0.2 g

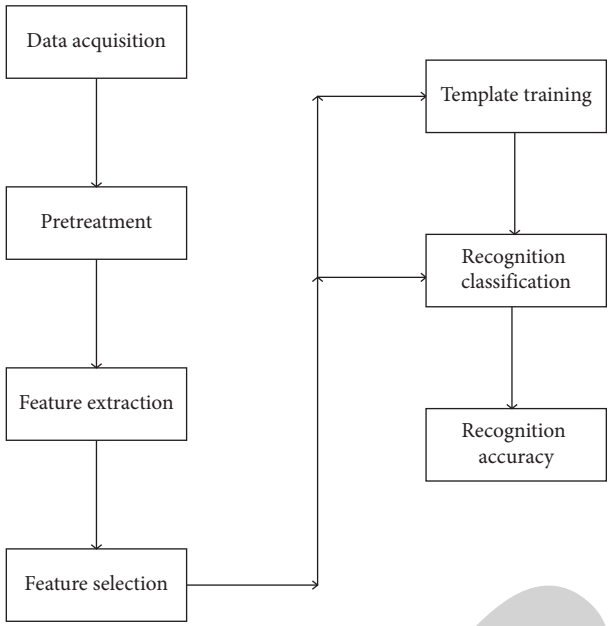

Figure 1: Human motion recognition process module.

calculations need to use the original data directly or indirectly. When designing the data acquisition device, we need to consider the particularity of users. The monitoring system is aimed at athletes who carry out martial arts training daily. If the wired transmission is used when choosing the data transmission mode, the comfort of the system will be greatly reduced and the completion of training actions will be affected. Therefore, it is suggested to use wireless data transmission and then process and calculate the data through external devices.

3.2.2. Pretreatment Module. Window processing: In the process of motion acceleration, signals are generally presented in the form of a data stream. When the data are too long, the results obtained by calculating this data stream are mostly meaningless. Therefore, we recognize the motion state by adding windows, as shown in Figure 2. The setting of window length is determined by specific action time, and there is a 50% overlap between each sliding window. In order to reduce the window effect on the data processing results when adopting windowing processing, that is, the action delay caused by a too large window and the incomplete action caused by too small window selection, we should carefully handle the window selection principle. It is shown in Figure 3.

As can be seen in Figure 3, the sliding window is an acquisition cycle for the corresponding signal, and the length of the window is 500. Only by continuously acquiring the information, can the data be effectively obtained, thereby improving the recognition efficiency of the algorithm.

Filter function: When measuring the actual acceleration data, due to the complexity of martial arts movements and the high sensitivity of sensors, the data results will inevitably be influenced by themselves and the outside world, including hardware circuit, transmission noise, disturbance frequency noise, and athletes' unconscious jitter. The acceleration of the output result generally consists of two parts, as shown in the following equation:

$$a_m = a_r + a_e, \tag{1}$$

where a_m is the actual measured value, a_r is the real acceleration from athletes, and a_e is the error acceleration from variable influences.

In order to reduce the errors from various aspects, the Kalman filter is selected for processing. This filter can process noisy input and observation signals in linear state space to obtain real data signals, and the processed data are obviously smoother, more stable, and more accurate. At present, this filtering method has been widely used in various fields of aviation, aerospace, and national economy and has become one of the most basic tools for processing and controlling signals; the motion data after the Kalman filter equation are obviously smoother and more continuous.

We build a mathematical model by Kalman filter, assuming that the system data, that is, the acceleration change trend, can be expressed by Xt, and we assume that the data of the system is the state in discrete time, and the state of the system is affected by the input data, and it is disturbed by the noise from the outside world in this process. Under the above assumption, we define the state of the system at k time as x_t (-stands for a priori and ^ stands for estimation) and derive the Kalman filter equation (1).

The state value $\hat{x}_{\bar{t}}$ of the system at time k is predicted by the optimal state value $\widehat{x_{t-1}}$ at time k−1 and U_{t-1} is the system input value at time k−1.

$$\hat{x}_{\bar{k}} = A\widehat{x_{k-1}} + BU_{k-1}. \tag{2}$$

We predict the new error $P_{\bar{k}}$ from the last error covariance Pk-1 and process the noise Q:

$$P_{\bar{k}} = AP_{k-1}A^T + Q. \tag{3}$$

We then calculate the Kalman gain as

$$K_k = P_{\bar{k}}H^T\left(HP_{\bar{k}}H^T + R\right)^{-1}. \tag{4}$$

Here, Kk represents the Kalman gain matrix, which mainly controls the weight of the observed quantity to the update of the estimated error state quantity. The rows of this matrix represent the state and the columns and represent the observed value. R represents the actual observation noise error covariance matrix, and there are interference factors in the information gain.

Then, a corrective update was carried out

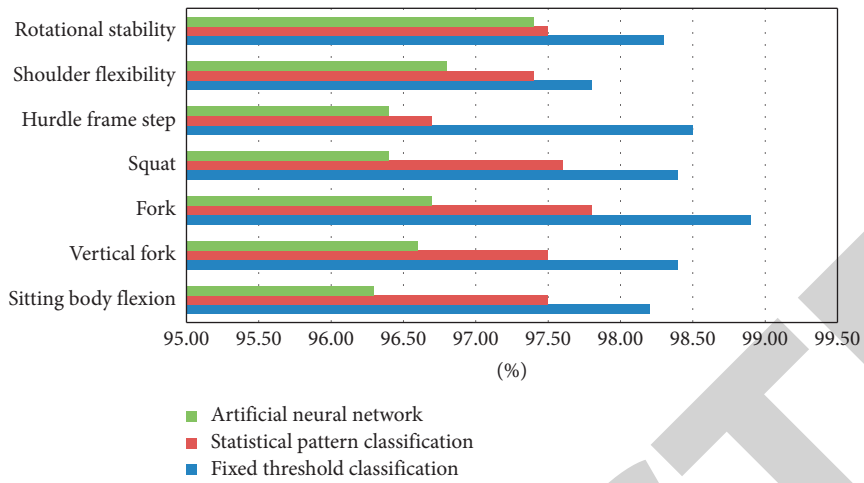

Figure 2: Comparison chart of classification algorithms.

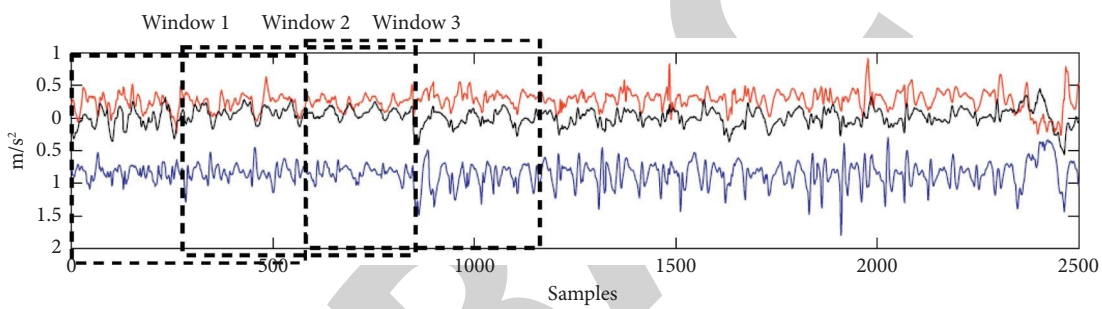

Figure 3: Windowing processing process.

$$\hat{x} = \hat{x}_k^- + K_k\left(y_k - H\hat{x}_k^-\right). \quad (5)$$

We then update P_k for the next iteration of estimating K+1 time.

$$P_k = (I - K_k H)P_k^-. \quad (6)$$

The parameters in the formula are explained as follows: A: $n \times n$ is the state transformation matrix on x_{k-1}; B is an $N \times 1$ input control matrix on the input data U_{k-1}; H is the $m \times n$ observation model matrix; I is the unity matrix of order $n \times n$; K_k is the $M \times N$ order matrix, representing the Kalman gain; and P_k^- is the $n \times n$ order prior error matrix.

3.2.3. Feature Extraction. The accurate judgment of action data in a wearable intelligent device system depends on the key characteristics of the recognized object and the accurate identification and grasp of the data. By selectively extracting the data in the memory, the numerical value that can fundamentally affect the result data is obtained, which plays a vital role in the whole system.

According to the statistics of feature extraction methods in wearable devices in recent years, the methods of extracting acceleration signals can be roughly divided into three categories: time domain analysis, frequency domain analysis, and time-frequency analysis. In this paper, based on the selection of time domain analysis methods that can be directly extracted from the acceleration signal, a simple method is selected in which the amount of calculation is moderate; so this method is selected for data extraction.

By using a three-axis acceleration sensor to obtain three-dimensional acceleration information, that is, X-axis, Y-axis, and Z-axis, and the acceleration reflects the vectors of different movements of Wushu athletes. In order to make the calculation simple, we introduce the amplitude change value of acceleration signal a_{SVM} to describe the acceleration of athletes' movements. Let us assume that the values of t, a_{SVM}, at any time are expressed by the following formula, where a_{xt} is the acceleration on the X axis, a_{yt} is the acceleration on the Y axis, and a_{zt} is the acceleration on the Z axis:

$$a_{SVM} = \sqrt{a_{xt^2} + a_{yt^2} + a_{xz^2}}. \quad (7)$$

However, due to the complexity and changing characteristics of martial arts athletes' movements, it is impossible to accurately judge their movement state only by using acceleration $\delta_{a_{\mathrm{SVM}}}$, so we once again introduce the change of acceleration, that is, variable acceleration $\delta_{a_{\mathrm{SVM}}}$, to describe the changes of athletes' movements. Variable acceleration can represent the speed described by visual icons. When using waveform icons to describe the changing trend of athletes' movements, $\delta_{a_{\mathrm{SVM}}}$ is the difference between adjacent peaks and troughs of $\delta_{a_{\mathrm{SVM}}}$. We judge that when the

Table 2: Wushu training contents.

Time	Content
10 minutes	Physical function training action preparation
20 minutes	Leg method: positive kick (8 × 2), side kick (8 × 2), bounce kick (8 × 2), and oblique foot pat (8 × 2)
20 minutes	Horse step changes to lunge punch, leg punch, kick and push palm, servant step piercing palm, and action combination
20 minutes	Twenty-four, a kind of traditional Chinese shadowboxing (tai chi chuan) and three short sticks.
10 minutes	Pattern relaxation run

Table 3: Basic information of test objects.

Characteristics	Subject	t	P
Height	178.25 ± 3.25	0.214	0.473
Weight	71.50 ± 4.874	0.365	0.632
Age	21.50 ± 2.31	0.475	0.521

Table 4: Physical fitness test index.

Action	Subject	t	P
Sitting body flexion (CM)	12.275 ± 3.25	1.245	0.124
Vertical fork (CM)	27.36 ± 4.124	−0.235	0.523
Fork (CM)	32.25 ± 5.321	0.135	0.124
1-minute sit-ups (times)	38.74 ± 5.325	0.245	0.214
Crane test (s)	12.125 ± 6.45	0.574	0.478

amplitude of acceleration change is less than 0.2 g and lasts for more than 5 s, we think that the athlete is in a static state.

3.2.4. Feature Selection. Due to the complexity of recognition action, the number of feature vectors extracted from data is large and the spatial dimension is high. How to select the data with association relationship from the extracted data and reduce data redundancy is also a link that cannot be ignored. Therefore, we often select after extracting relevant feature information and exclude those disturbing and irrelevant data. Common feature selection methods include principal component analysis (PCA), linear decision analysis (LDA), and so on.

Linear decision analysis is an improvement of principal component analysis, which has the best discrimination in the sense of minimum mean square error. Based on this analysis, we can reduce the data dimension, thus simplifying the algorithm and saving memory space.

4. Recognition of Wushu Action Training Efficiency

4.1. Data Analysis of Wushu Action Training. Modern functional training concept holds that balance ability, flexibility, sensitivity, and coordination constitute the foundation of physical fitness and are the foundation of strength, speed, and endurance. Among them, physical fitness is concentrated in the maneuverability required by sports, and maneuverability is a purposeful action based on stable body posture, which reflects the dynamic control of athletes' body stability and maneuverability, respectively.

The premise of normal special technical teaching and training of Wushu training content, physical function training action preparation exercises, and the content arrangement is given in detail in Table 2. The basic situation of the subjects is shown in Table 3, and the physical fitness test indexes are shown in Table 4.

As can be seen from Table 4, the average scores of the experimental group's sitting body flexion, vertical fork, horizontal fork, one-minute sit-up, and stand-out test are 12.275 cm, 27.36 cm, 32.25 cm, 38.74 times, and 12.125 seconds.

4.2. Comparison of Wushu Action Training Recognition. According to the characteristics of the system audience and motion features, motion recognition algorithms have their own emphasis. Common classification algorithms include fixed threshold classification, statistical pattern classification, and artificial neural network classification algorithms. The fixed threshold algorithm is simple, efficient, and easy to operate by dividing the data and judging the input data directly. At present, most monitoring systems about falls use this algorithm for action classification. Statistical pattern classification takes the sample data stored in the system as the standard and divides the research objects into their own fields before analyzing the data. Common statistical methods include the C4.5 decision tree, hidden Markov model, K nearest neighbor algorithm, and so on. From the perspective of martial arts training, the recognition and classification algorithm meets our requirements. An artificial neural network

Hindawi
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Retraction

Retracted: Construction and Simulation of the Enterprise Financial Risk Diagnosis Model by Using Dropout and BN to Improve LSTM

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] W. Yang, C. Jia, and R. Liu, "Construction and Simulation of the Enterprise Financial Risk Diagnosis Model by Using Dropout and BN to Improve LSTM," *Security and Communication Networks*, vol. 2022, Article ID 4767980, 9 pages, 2022.

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Research Article

Construction and Simulation of the Enterprise Financial Risk Diagnosis Model by Using Dropout and BN to Improve LSTM

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In view of the financial risks faced by listed enterprises, how to accurately predict the risks is an important work. However, the traditional LSTM financial diagnosis model has the disadvantage of low accuracy; the specific reason is that the LSTM model has the problems of overfitting and gradient disappearance in risk diagnosis. Therefore, Dropout is adopted to solve the overfitting problem in the process of premodel prediction, and the BN algorithm is used to solve the gradient disappearance problem in the process of iteration. In order to verify the feasibility of above improvements, the financial data of China's A-share listed enterprises from 2017 to 2020 are taken as samples to analyze the financial data of listed enterprises through single-step dimension and multistep dimension. The experimental results show that under the analysis of two dimensions, the financial prediction accuracy of the improved LSTM for T-2~T-3 years can reach 83.96% and 91.19%, respectively, which indicates that through the above improvements, the model can be improved and has certain reference value.

1. Introduction

As an important branch of machine learning, with the help of internally complex mapping relationships, deep learning algorithms can extract features more efficiently. In virtue of the strong self-learning ability, it is widely used in image processing, education, architecture, UAV, medicine, and so on. For example, Gu et al. applied the GISTNet diagnostic model to the diameter of more than 5 cm gastrointestinal mesoma and stomach benign SMT diagnosis, and the results show that the diagnostic accuracy of the GISTNet depth model is much higher than that of manual diagnosis [1]. Liu et al. applied the AlexNet neural network to the automatic classification of indentation, and the results show that the accuracy of the individual recognition of the AlexNet model can reach more than 90%, and the individual image recognition rate can reach 28.26 ms [2]. Seok-Jae Heo et al. applied multiple deep learning algorithms to architectural color drawing, thus greatly reducing the difficulty of artificial restoration of ancient architectural color painting. It can be seen that the deep learning algorithm has become a hotspot of the current application and research. Deep learning algorithm is also applied to the field of financial early warning and anomaly recognition [3]. For example, Amit et al. applied the deep learning algorithm to the stock market, so as to provide effective solutions for them to forecast the risks as quickly as possible, but the research was limited to the idea [4]. Lu and Dong applied the deep confidence neural network to the power grid supplier and in the identification risk, concretely. The results also show that with the training ratio of more than 90%, the test accuracy can reach 92.56%, effectively realizing the identification risk [5]. XianTian established the deep learning model of the China aviation real estate enterprise risk warning model. The results show that AVIC has financial risks in 2016 and 2017, in line with the actual financial situation [6]. Zhao used the quantitative analysis method to evaluate financial risks, but this method has certain subjectivity [7]. Zhang et al. used the random forest algorithm to evaluate financial risks, which provides a reference for the evaluation of financial risks of supply chain

[8]. Through the above research, it can be seen that trying to apply different deep learning algorithms in financial abnormal recognition and risk warning can not only improve the accuracy of financial recognition but also become the focus of discussing and studying the application of deep learning. However, in the above studies, some risk evaluation methods have strong subjectivity, such as hierarchical analysis, and some have low accuracy of evaluation. Therefore, on the basis of the above research, taking into account the time series relationship of financial data, a financial abnormal recognition model based on LSTM is proposed, and the accuracy of this model is verified. In addition, the innovation of this study is to try to propose a more informative and objective evaluation method.

2. Basic Principles and Structure of the LSTM Neural Network

2.1. Basic Principles. LSTM belonging to temporal-recurrent neural networks has evolved to address the long-term dependence of traditional RNN recurrent neural networks [4]. Therefore, the basic structure of LSTM follows the structure of the recurrent neural network. It composed of the input layer, hidden layer, and output layer, by establishing the continuous relationship between the upper time node and the next time node for output, as shown in Figure 1 [9–11].

However, it was found by research that recurrent neural networks, so LSTM add three gating units, could influence real-time information on historical information better, so to obtain long-term retention and memory purposes and avoid gradient disappearance or the emergence of gradient expansion.

2.2. Basic Structure. Each LSTM unit contains one memory unit and three gating units, and the specific structure is illustrated in Figure 2. Memory unit is mainly used to record the state of each neuron; input and output gates are mainly used to solve the data reception and correct parameter and output; the forgetting gate mainly controls how much the neural unit state is forgotten [12–17].

The calculation formulas of forgetting gate, input gate, and output gate are as follows:

$$\begin{aligned} f_t &= \sigma\left(W_f \cdot (h_{t-1}, x_t) + b_f\right), \\ i_t &= \sigma\left(W_i \cdot [h_{t-1}, x_t] + b_i\right), \\ o_t &= \sigma\left(W_o \cdot [h_{t-1}, x_t] + b_o\right). \end{aligned} \tag{1}$$

Among them, h_{t-1} represents the output of the LSTM neuron at the $t-1$ moment, and $[h_{t-1}, x_t]$ is defined as the connection of the two vectors into a longer vector. W_f, b_f, and f_t, respectively, are the weight, bias top, and state of the forgotten door to the input sequence, and W_i, b_i, and i_t are the weight, offset top, and state of the input gate. W_o, b_o, and o_t are the weight, bias top, and state of the output gate; σ is the activation function of the output. Then, the calculation of LSTM outputing h_t is as follows:

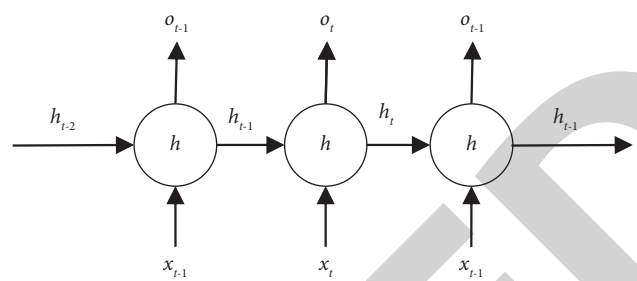

Figure 1: Basic structure of the LSTM.

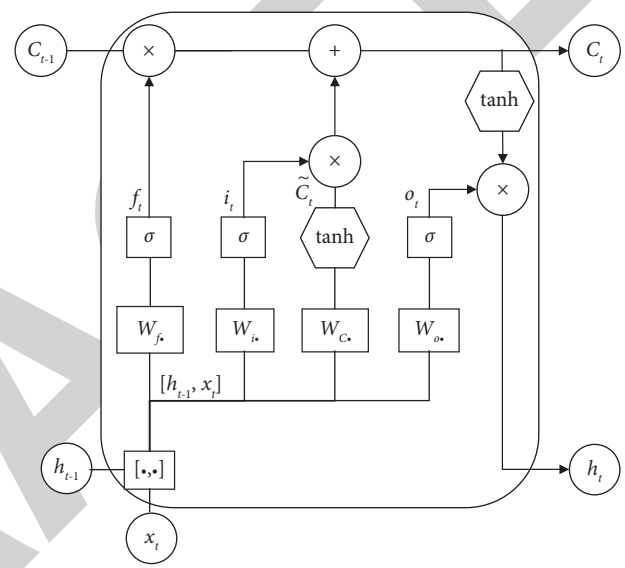

Figure 2: The unit structure of LSTM.

$$\begin{aligned} \tilde{C}_t &= \tanh\left(W_c \cdot [h_{t-1}, x_t] + b_c\right), \\ C_t &= f_t * C_{t-1} + i_t * \tilde{C}_t, \\ h_t &= o_t * \tanh\left(C_t\right). \end{aligned} \tag{2}$$

It can be seen that $\tilde{C}_t$ represents the instantaneous state of input feature at time t, C_t is the current unit state, tanh is the activation function of output feature, and h_t is the output of the current unit.

Through the elaboration of the principles and structure, it can be seen that the LSTM neural network can solve the data with long-term dependencies and realize the mining of such data intrinsic connection better. In the business operation, financial crisis is not only a process of continuous accumulation of financial risks but also a concentrated embodiment of the risk accumulation to a certain extent. Therefore, the essence of financial warning for enterprises is to analyze this long-term dependence on data, so as to predict the probability of financial crisis in the next financial year and achieve the purpose of financial warning for enterprises.

3. Improvement of the LSTM Neural Network and the Model Construction

3.1. Model Improvement. Considering the gradient disappearance and overfitting problem, in the LSTM neural

network model construction, two solution strategies are proposed. First, to introduce Dropout for the overfitting problem. During network training, Dropout would set an inactivation probability for neurons on each layer of the network. Based on it, the network automatically eliminates the neurons to simplify the network structure and avoid overfitting [18–23]. For the gradient vanishing problem, the BN algorithm is introduced. The LSTM neural network designed in this study adds the Dropout and BN algorithms to optimize the network structure. The specific improvement process is shown in Figure 3.

In order to solve the problem of gradient disappearance, the standardization layer is added to the output of the convolution layer, so as to readjust the input. The traditional dimension standardization formula is [24]

$$\widehat{x}^{(k)} = \frac{x^{(k)} - E\left[x^{(k)}\right]}{\sqrt{Var\left[x^{(k)}\right]}}, \tag{3}$$

where $E[x^{(k)}]$ is the expected value of neuron $x^{(k)}$ in each batch of data; $\sqrt{\mathrm{var}[x^{(k)}]}$ represents the standard deviation of $x^{(k)}$ activation value. The same time, dimensionality is standardized, which will directly affect the characteristics of the network at the upper layer as well as the data and parameters at the lower layer. Therefore, the BN algorithm is introduced. The most effective part of the algorithm is the addition of learning parameters γ and β.

$$y^{(k)} = \gamma^{(k)}\widehat{x}^{(k)} + \beta^{(k)}. \tag{4}$$

The features conforming to normal distribution are reduced to some extent, so as to maintain the original distribution trend of features. And the degree of reduction is learned by the network itself.

$$\begin{aligned} \gamma &= \sqrt{\mathrm{Var}\left[x^{(k)}\right]}, \\ \beta &= E\left[x^{(k)}\right]. \end{aligned} \tag{5}$$

The forward conduction formula of the BN algorithm is

$$\begin{aligned} \mu_B &\leftarrow \frac{1}{m}\sum_{i=1}^{m} x_i, \\ \sigma_B^2 &\leftarrow \frac{1}{m}\sum_{i=1}^{m}\left(x_i - \mu_B\right)^2, \\ \widehat{x}_i &\leftarrow \frac{x_i - \mu_B}{\sqrt{\sigma_B^2 + \varepsilon}}, \\ y_i &\leftarrow \gamma\widehat{x}_i + \beta \equiv BN_{\gamma,\beta}(x_i). \end{aligned} \tag{6}$$

The principle of the Dropout algorithm is that the weights of the neural network are not updated during the backpropagation process, but the weights are preserved for the next training. In this way, part of the neural network nodes can be removed, so that the size of the network will not grow too fast. After the training set enters the convolutional neural network, its output is the output of all networks, which makes the output result more stable and more reliable. The specific formula is as follows:

$$R = m * a(WV), \tag{7}$$

where W is the matrix of $d * n$; V means the column vector of $n * 1$; m represents the 01 column vector of $d * 1$; $a(x)$ stands for activation function.

3.2. Training Method and Optimizer Selection. This paper trains the LSTM network through the minibatch method. The ultimate goal is to forecast the future closing price of the business interests. Therefore, the loss function of this study uses mean square error, MSE [25–27]. Meanwhile, in order to better conduct the network optimization training, the Adam optimizer is selected in this study. The optimizer is the most widely used in the field of deep learning, which has more efficient convergence speed and stronger learning effect than other algorithms.

4. Test Validation

4.1. Selection of Financial Indicators. Mo Qi Kong et al. took debt paying ability and operating capacity as evaluation indexes to set up the financial risk evaluation system [28]. Zhao et al. took port enterprises as an example and adopted the method of factor analysis to build the evaluation system, including development potential and profitability [29]. Anzhong Huang et al. selected the financial risk indicators from 18 dimensions, such as weighted average interest rate, money supply M2, effective exchange rate, and so on. However, the above indicators are mainly selected from the market perspective [30]. Fitzpatrick Trevor et al. constructed financial risk indicators from the perspective of enterprises, which are based on the indicators such as solvency, profitability, and so on [31–33]. This paper mainly aimed at the listed companies. Therefore, with the reference to the above financial risk indicators, a risk indicator early warning system is constructed from seven perspectives including debt paying ability. The main financial indicators are given in Table 1.

4.2. Sample Selection and Data Preprocessing

4.2.1. Sample Source. According to the current listed company system in China, the companies listed in * ST are usually in extreme financial deterioration status. Therefore, the A-share listed companies in China from 2017–2020 were selected as the experimental samples, including those listed in * ST from 2017 to 2020. At the same time, considering that the financial dilemma is a process accumulated in time, therefore, the probability of possible financial crisis is predicted from two dimensions of both single-step and multistep length. The prediction accuracy in the same dimension and different dimensions is compared, respectively, so to determine the best time steps. Among them, the train of thought of single-step dimension prediction is as follows: the data from T-2 (2020), T-3 (2019), and T-4 (2018) are used to predict the

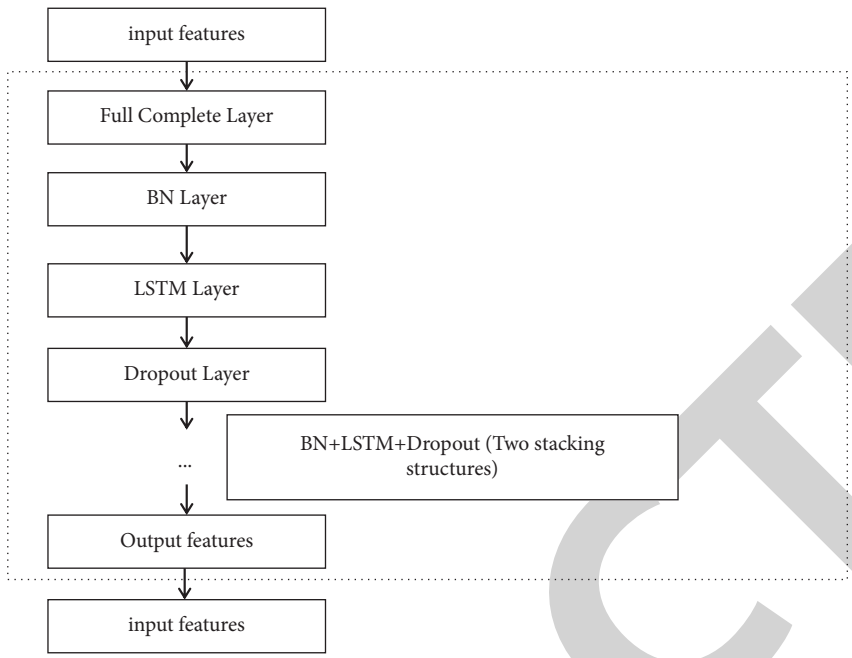

Figure 3: Computational graph structure of the deep LSTM neural network.

Table 1: Financial early warning index system based on LSTM.

	Selected index	Abbreviation
Debt paying ability	Cash ratio	CR
	Asset-liability ratio	LEY
	Cash flow ratio	CASHCL
Operating capacity	Accounts receivable turnover rate	ARTURNOX
	Inventory turnover	INTURNOX
	Turnover rate of current assets	VOL
	Total asset turnover	TATO
Development capacity	Growth rate of operating income	RG
	Growth rate of operating profit	PGR
	Net profit growth rate	EG
	Growth rate of total assets	TAGR
Earning power	Return on assets	ROA
	Net interest rate of total assets	ROT
	Return on net assets	ROE
	Net operating interest rate	NPM
	Return on investment	ROI
Cash flow analysis	Net cash flow from operating activities per share	NCFOPS
	Cash recovery rate	CRA
Ratio structure	Cash asset ratio	CAR
	Fixed assets ratio	LTCR
Profitability	Asset remuneration rate	HERF

financial situation of T years. Through three training, the single annual samples with the highest prediction accuracy were obtained. The train of thought of multistep dimension prediction is to predict the financial status of T years with data from T-2 to T-3 years (2019) (2018) and T-2 to T-5 years (2017), to obtain the training samples with the highest prediction accuracy. Then, compare the prediction accuracy of the two dimensions to select the best prediction time steps. Samples from Tables 2 and 3 were selected by methods above.

According to Tables 2 and 3, 9258 samples in total were used for the LSTM nerve net training and testing.

At the same time, according to the financial warning indicators in Tables 2 and 3, the financial data of some listed companies are given in Table 4.

4.2.2. Data Preprocessing. From the financial data obtained above, the different index data collected have big differences. For convenient training, standardized processing of the

Table 2: Sample distribution of the financial early warning model of listed companies under single-step dimension.

Forecast dimension	Year	Training sample		Test sample	
		The finance is normal	Financial difficulties	The finance is normal	Financial difficulties
Single-step length	T-2 year	2133 (2020)	132 (2020)	25 (2019)	25 (2019)
	T-3 year	2131 (2019)	132 (2019)	25 (2018)	25 (2018)
	T-4 year	2133 (2017)	132 (2017)	25 (2017)	25 (2017)

Table 3: Sample distribution of the financial early warning model of listed companies under multistep dimension.

Forecast dimension	Year	Training sample		Test sample	
		The finance is normal	Financial difficulties	The finance is normal	Financial difficulties
Multistep dimension	Year of T-2 to T-3	2131 (2019)	132 (2019)	2133 (2020)	132 (2020)
	Year of T-2 to T-4	4264 (2018~2019)	264 (2018~2019)	2133 (2020)	132 (2020)
	Year of T-2 to T-5	4264 (2017~2018)	264 (2017~2018)	4264 (2019~2020)	2 (2019~2020)

Table 4: Some training samples of financial normal listed companies.

Stock	Year	LEV	TATO	ROA	NPM	CRA	HERF
0000**	2017	0.2106	0.3255	0.0822	0.2520	0.0872	24.4122
...	...	...	...	...	...	...	...
000*63	2018	0.8414	0.7226	-0.0343	-0.0465	0.0340	30.3451
...	...	...	...	...	...	...	...
000**7	2019	0.6693	00176	0.0358	0.0709	0.0043	43.1718
...	...	...	...	...	...	...	...
0007**	2020	0.6375	2.3901	0.0191	0.0016	−0.0585	16.6620

Table 5: Training samples from financial normal listed companies after preprocessed.

Stock	Year	LEV	TATO	ROA	NPM	CRA	HERF
0000**	2017	0.3745	0.0601	0.7885	0.1395	0.6140	0.7148
...	...	...	...	...	...	...	...
000*63	2018	0.8407	0.3020	0.6684	0.1320	0.6458	0.3977
...	...	...	...	...	...	...	...
000**7	2019	0.6024	1.0000	0.7376	0.1331	0.5010	0.1495
...	...	...	...	...	...	...	...
0007**	2020	0.7263	0.0957	0.7131	0.1319	0.5973	0.0633

above financial data was performed. A common method is to scale the raw data to 0-1 [10] by proportion. Therefore, this study selects the MinMaxScaler of the scikit-learn library in Python3.6.4 and normalized the data to 0-1, with the normalization formula as

$$X_{\text{scoled}} = \frac{(X - X_{mi}n(\text{axis} = 0))}{(X_{\max}(\text{axis} = 0) - X_{\min}(\text{axis} = 0))} \cdot (\max - \min) + \min. \tag{8}$$

In the above, X is the characteristic value to be normalized, while $X_{\min}$ the minimum and $X_{\max}$ the maximum of the character, respectively, min and max represent the range of values be set normalized, and axis = 0 represents the normalization of each column by default [11]. Better training effect can be achieved by training of scaled data in the deep LSTM neural network of the financial early warning model.

To facilitate the comparison of data set changes before and after data preprocessing, the results of the pretreatment of training samples of financially normally listed companies are shown in Table 5.

4.3. LSTM Specific Parameter Design. According to the results of some researchers, the parameters design of the LSTM neural network is as shown in Figure 4.

In Figure 4, input represents the input dimension of each network layer, and output represents the output dimension, both the input and output are 3D data. According to the arrow transmission direction of Figure 4, the top layer is the input layer, and the input data is a time step, all contains datasets with 32 features. Then, in the BN layer, the input dataset is normalized by using the BN algorithm [12]. Then, there is the LSTM layer, with the hidden nodes of 50,512,512, and 2 neurons in each layer. Then, it is the Dropout layer. This layer does not change the input and output dimensions, only updates the network parameters, and disconnects the neurons of the input layer according to a certain proportion, so to avoid overfitting problem. Through the four superposition of the three network layers mentioned above, the network output layer is finally obtained, and the input dimension is the output of the previous layer.

4.4. LSTM Training Process. The overall training process of the LSTM financial warning model is shown in Figure 5.

First, input the learning sample, preprocess sample data, and convert timing data into supervised data to learn the processed data by preset earning parameters. Then, calculate the input and output values of units of each layer [13]; then, deviation of the target output and the actual output is calculated. If the calculation results converge, it predicts sample data inverse scaling and gives the prediction value, and then the algorithm ends. If there is no convergence, the neural network hidden layer nodes and learning times of LSTM will need to be adjust, and learning mode will be updated; sample learning will restart to guide the determination of optimal network parameters.

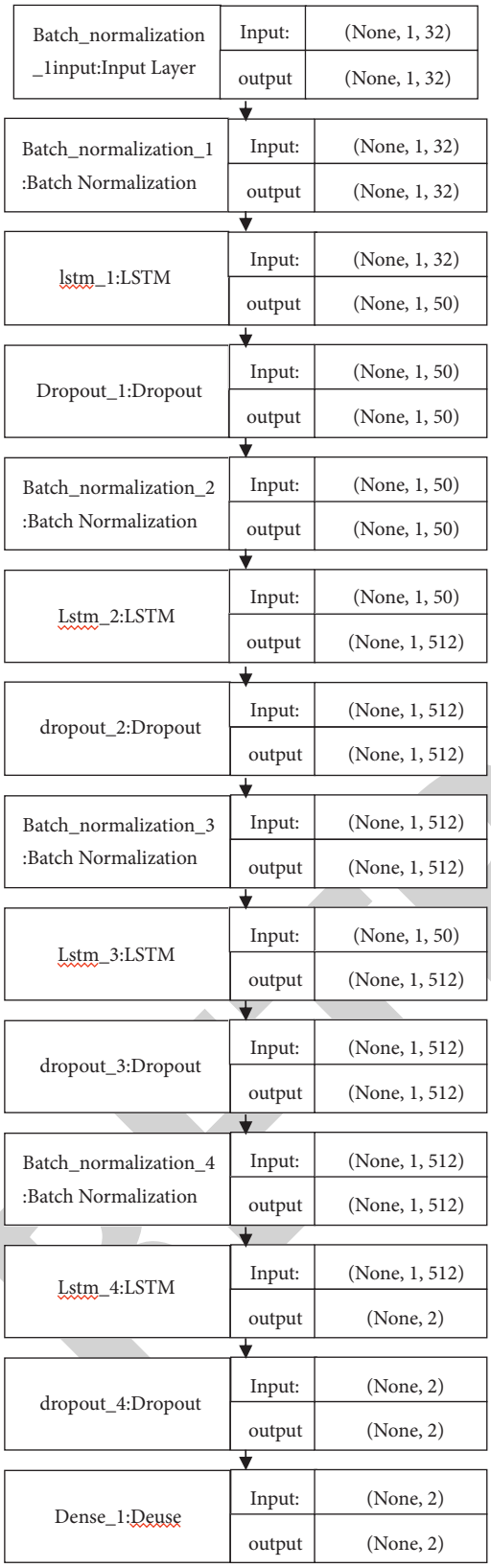

Figure 4: The LSTM neural network parameter design.

4.5. Results and Analysis

4.5.1. Loss Function and Accuracy Changes in Different Dimensions. In this study, the number of neurons in the LSTM layer is set to 50,512,512,2, and there is one neuron in the output layer. The loss function uses the average absolute error MAE, the basic principle of which is to summarize the difference between the predicted value and the actual value, and it can be clearly seen the deviation amplitude of the forecast value. In the meantime, Adam stochastic gradient descent is used for network optimization, which can make the learning rate adjusted more effectively. The activation function of the LSTM layer is the sigmoid function, with a learning rate of 0.01, the iterations of 200, and the batch of 64.

To better understand the situation of loss function and accuracy changes during training, this study will show the training process of the step dimension T-2 year and the multistep dimension T-2 to T-3 years in Figures 6 and 7.

Figures 6 and 7 show that loss and val_loss are the changes of loss function in the training set and test set samples, respectively, and acc and val_acc are the change of prediction accuracy in training set and test set, respectively.

As can be seen from Figures 6 and 7, mean absolute errors in both different dimensions are in a downward trend, with all improvements in accuracy, but the growth stops when a certain range is reached, indicating that the model is gradually stable. The sharp decline of MAE in training set indicates that the imitative effect of the model is better, and the MAE of the training set and test set are converged, indicating that the training attained the expectant goal.

4.5.2. Loss Curve at Different Learning Rates. In deep learning, gradient descent is one of the most widely used optimization methods, but the two ways of batch and random gradient descent use the most. In line with the actual requirements of the experiment, this study chooses to use stochastic gradient descent, which only updates one data at a time, and the training speed is fast, but the disadvantage is that it is difficult to converge the minimum value. Through the experiment, it is found that reducing the learning rate can minimize the convergence of training results, and by constantly adjusting the parameters, the convergence effect of MAE can be improved, and the best training results can be obtained. Thus, the multistep dimension T-2 to T-3 years loss curve is as follows:

In Figure 8, the blue curve is the training set loss curve, and the orange one indicates the test set loss curve; the horizontal axis represents iterations during sample training, while the vertical axis represents the average error value change. It is seen from Figure 6 that the sample error decreases with the number of iterations increase, with local fluctuations in a small range. During initial training, the error dropped sharply from 10 to 50 sessions. Errors quickly

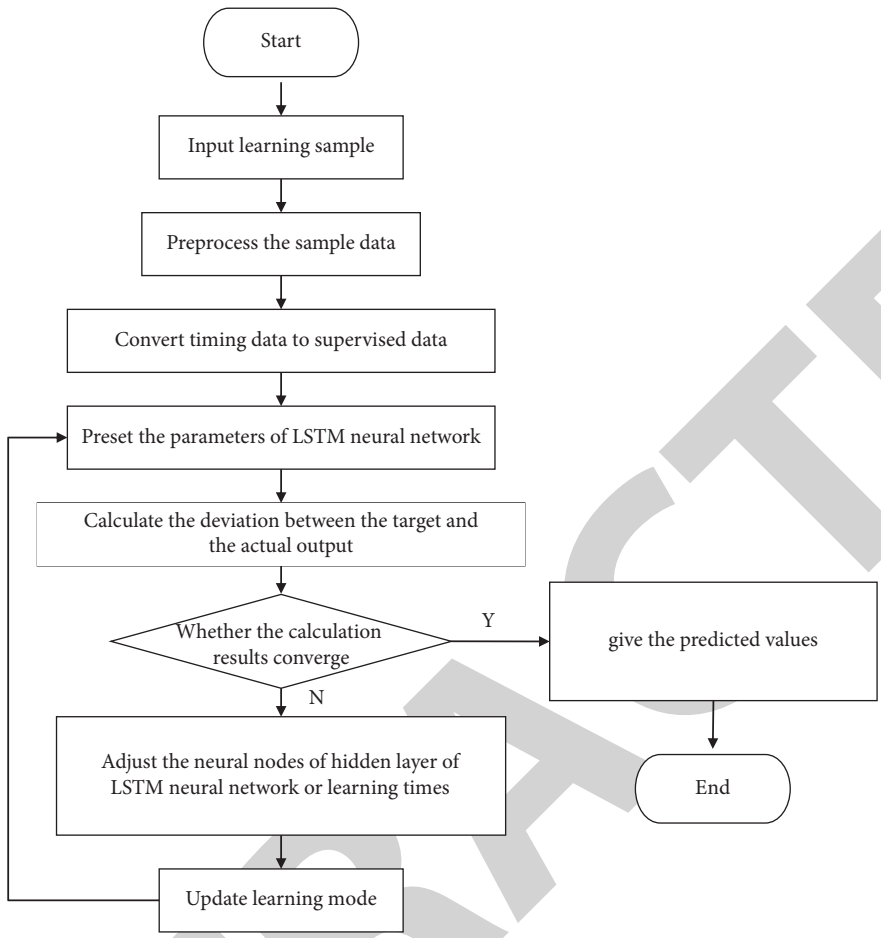

Figure 5: Data processing algorithm flow for the LSTM neural networks.

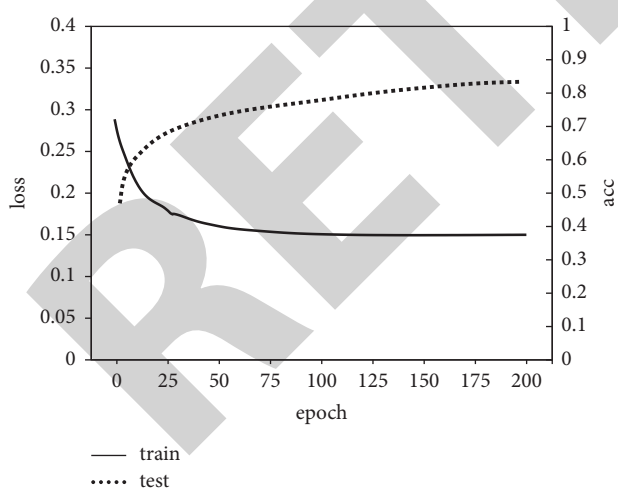

Figure 6: Training process of a single-step dimension T-2 year.

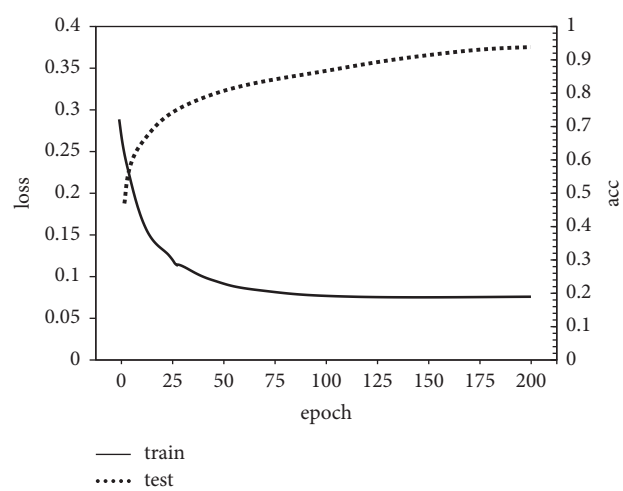

Figure 7: Training process of the multistep dimension T-2 to T-3 years.

dropping indicate that the model had fine-tuning. At the beginning of 100 sessions, the decrease in error gradually stabilized, which indicates that the model was close to the optimal process. According to the comprehensive analysis, the error of the training sample finally converged successfully and the fitting effect was good; the test sample error converged to local minimum. The fitting effect was poor compared with the training sample, but the stochastic gradient descent method used in this study optimized a good effect and had little impact on the model performance.

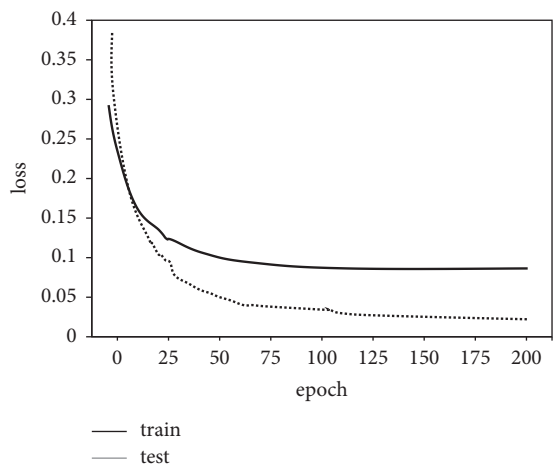

Figure 8: Loss curve for the multistep dimension T-2 to T-3 years.

4.5.3. Financial Early Warning Results and Analysis

(1) Financial Early Warning and Evaluation Indicators. This study selected the adaptive moment to estimate Adam stochastic gradient descent for optimization, to adjust the learning rate of each parameter dynamically, and evaluated the LSTM financial warning model by using the root mean square error RMSE. The computational expression for RMSE is

$$\mathrm{RMSE} = \sqrt{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{y}_i - y_i\right)^2}. \tag{9}$$

The range of RMSE is $[0, +\infty]$, the greater the error of the real value, the greater the value of RMSE. After many experiments, the RMSE of financial warning model based on the deep LSTM neural network was 29.7, indicating that the model predicted small error with real value and the model fit is high.

(2) Financial Early Warning Results. In order to see the normal financial situation or financial difficulties of the enterprise better, the status column is added to the normalized data, and 0 represents normal situation and 1 represents financial difficulties. After reverse scaling the data, the prediction of the output status bar puts the output above 0.5–1, under 0.5–0, thus the final prediction result is shown in Figure 9.

As we can see from Figure 6, in the single-step dimension, the prediction accuracy of T-2, T-3, and T-4 years is 84.67%, 84.01%, and 84.11%, respectively. The sample data close to the prediction year is with higher prediction accuracy. In multistep dimension, T-2 to T-3, T-2 to T-4, and T-2 to T-5, the prediction accuracy is 91.19%, 90.02%, and 90.05%, respectively; those two years close to the predicted year have higher step length prediction accuracy.

It can be known from the comprehensive analysis that in the financial prediction based on the deep LSTM, the financial data using T-2 to T-3 has the highest accuracy in the neural network model.

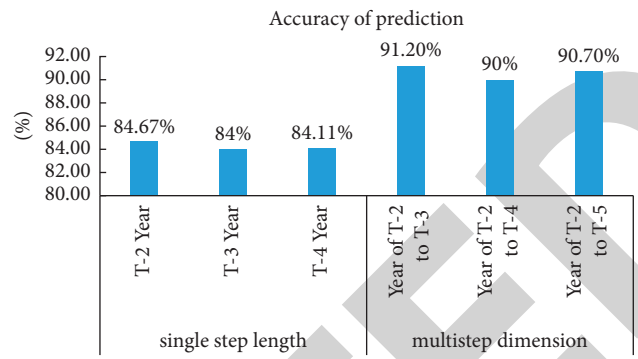

Figure 9: Financial early warning results based on the deep LSTM neural network model.

5. Conclusion

In conclusion, the LSTM financial warning model proposed in this study has small error and good fit. Experimental results show that they are narrow in both single-step and multistep dimensions. The prediction accuracy of T-2 year and T-2 to T-3 years is 83.96% and 91.19%, respectively, indicating that the multistep dimensional prediction of T-2 to T-3 years has the highest prediction accuracy and can more effectively predict the financial status of listed companies in T years. It verifies that the model of this study can be used in the early warning of the company finance.

Data Availability

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

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

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Retraction

Retracted: Enterprise Financial Risk Prediction and Prevention Based on Big Data Analysis

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] J. Cheng, "Enterprise Financial Risk Prediction and Prevention Based on Big Data Analysis," *Security and Communication Networks*, vol. 2022, Article ID 1442999, 12 pages, 2022.

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Research Article

Enterprise Financial Risk Prediction and Prevention Based on Big Data Analysis

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With the rapid development of the times, the financial status of many enterprises has become the top priority, and the prediction and prevention of enterprise financial risks are more important. The financial risk prediction of enterprises under big data can better collect data and analyze it, which can help workers bring convenience. In order to make the public better understand the corporate financial risk forecasting, the research on the prediction and prevention of corporate financial risk based on big data analysis is as follows: (1) the broad and narrow senses of corporate finance readers gain a clearer understanding of the importance of corporate finance; (2) an introduction to the calculation algorithm of enterprise financial risk, which facilitates the staff to better calculate the financial risk of the enterprise and establish a financial risk model; (3) conduct an example investigation on a representative pharmaceutical company, analyze its various financial indicators, and compare with the indicators in the same industry to judge whether the financial data is normal; and (4) conduct comparative research on corporate finance under big data and find that big data can better prevent corporate financial risks. It is concluded that this risk prediction method is very effective. It shows that corporate financial risk is very important to social development, and based on big data, risks can be better predicted and prevented.

1. Introduction

Large datasets and big data analytics present significant challenges to the people. The data in the dataset comes from various fields, such as: social networks, science and technology, biomolecules, and many other aspects. A lot of information can be extracted from the data, and we process the data in innovative ways. This article describes an approach based on discrete signal processing (DSPG) data on graphs. The concepts and processing methods of DSPG are reviewed and compared with their counterparts in classical signal processing theory [1]. Virulence Factor Database (VFDB) is used to provide up-to-date knowledge about its development. For development purposes, we have recently improved two aspects of VFDB to make the dataset more complete and to improve data quality, promoting the availability of databases in the era of big data for bioinformatics mining of explosively growing bacterial VF data [2]. In many fields such as the Internet and e-commerce, the unanalyzed data is increasing rapidly, and parallel technology that can be processed should be invented. Relational data management technology has developed for 40 years and should develop its scalability. Relational technology does not handle data easily, and at the same time, there is no new force emerging and extending its application from web search to areas once occupied by relational database systems. Facing relational technology has many advantages [3]. Crowd sensing leverages the power of crowds to collect large volumes of characterization data through a large number of users of mobile and networked devices. This traditional method is quite challenging. Although several big data-based human behavior analysis methods have been proposed, the common characteristics have not been studied. This paper designs a community-centric approach for community activity prediction; specifically, we propose a method to extract community activity patterns by analyzing big data collected from the physical world and virtual social spaces [4]. With the continuous development, the data on the power user side increases exponentially, gradually forming the big data on the power user side. Traditional data

analysis can no longer be satisfied, and a new data analysis model for analyzing and processing big data on the power user side is urgently needed. The sources of its data are analyzed, and various challenges faced by the data on the power user side are pointed out. Combined with cloud computing, the processing method and application of big data analysis on the power user side are given [5]. The term big data has received little attention in economics, although the availability of large datasets and the need for new methods is a new issue. Through interviews, this paper explores interdisciplinary perceptions of big data, the new types of data the researchers are using on economic issues, and the range of economists' responses to this opportunity [6]. The approach to handling huge datasets has shifted from a centralized architecture to a distributed architecture. Enterprises need to collect a large amount of data and cannot use centralized solutions to solve the problems. Not only it does not allow time, but also the efficiency is very low. With the help of distributed architecture, large organizations can better extract information and process the data [7]. Recent advances in high-throughput technologies have led to the emergence of systems biology as a holistic science that allows for more precise modeling of complex diseases. A lot of people have predicted the arrival of personalized medicine in the near future, however, we are moving from a two-tiered healthcare system to a two-tiered personalized medicine. Omics facilities are limited to affluent areas. Personalized medicine can widen the widening gap in healthcare systems between high- and low-income countries. This is reflected in the growing disconnect between our ability to create and analyze big data. Several bottlenecks are slowing the transition from traditional to personalized medicine: high-throughput, cost-effective data generation. Hybrid education and multidisciplinary team data storage and processing integrate and interpret personal and global economic data and correlations [8]. With the development of computer technology, there has also been a huge increase in the amount of data growth. Scientists are overwhelmed by the growing need for data processing in every field of science. How to make full use of these large-scale data to support decision-making has encountered great problems in various fields. Data mining is a technique that can discover new patterns from large datasets. Over the years, it has been studied in various application fields; so many data mining methods have been developed and applied in practice [9]. This examines how financial sector development policies can contribute to poverty reduction. This is especially done by supporting the growth of Small and Micro Enterprises (MSEs). Use case studies and empirical work on the changing role of MSEs in development and access to formal and informal financing for MSEs, including the role of microfinance [10]. The relationship between the capital needs of enterprises and economic efficiency and the adverse effects of credit barriers on industrial investment are discussed. Some of the insights gathered are then applied to financial intermediation and financial structuring. Trade credit is the subject of special scrutiny because it plays a key role in corporate financing in Kenya, as elsewhere. The causes of credit barriers are also examined in detail. Particular emphasis is placed on information and contract enforcement issues [11]. Entrepreneurship is elevated to an internationally disadvantaged labor market. The policy increasingly draws on the concept of social inclusion. In this article, we define a "corporate inclusion" policy as a right to recognize the opportunity to do a viable business and to support multiple disadvantaged groups in overcoming the powerful barriers facing businesses. We use a resource-based view of entrepreneurship to argue that viable business ownership depends on access to resources. We explore the relationship between access to a primary business resource—start-up capital—and intersecting social disadvantage. We report a complex pattern of financial exclusion [12]. Statistics, the areas under Routing of Service (ROC), are published in the diagnostic tests, where sensitivities and characterizations are relevant to the identified patients. Because estimation models can predict future risk or classify individuals into risk categories, in which case it is equally important to assess the validity of calibration tests, possibly the effect on statistics may be small. But the level of increased cardiovascular risk can increase from 8% to 24% over 10 years. Reference [13]. Better screening techniques for early detection of breast cancer are painless, which is why clinicians are committed to providing appropriate plans to protect the patients. These are especially important for family history of breast cancer. Moderate chemotherapy studies were performed on population data where cancer and steroid hormone studies were performed and on the risk assessment in women with a family history of cancer [14]. The guidelines recommend coronary heart disease risk (CHD) assessment for all adults to guide the severity of preventive treatment, although the Framingham Risk Score (FRS) is generally recommended for this purpose. However, it is recommended that additional tests, such as the Coronary Calcium Score (CACS), will improve risk assessment. Objective: To determine whether CACS and FRS assessments provide better prognostic information than either method in asymptomatic adults and whether this approach is associated with more precise prevention strategies in patients with risk factors for primary heart disease prevention [15].

2. Corporate Financial Capability

2.1. Generalized View of Corporate Financial Capability. According to the theory of enterprise competency, the financial capability of an enterprise is a subsystem composed of the corresponding part of the financial-related capability in the enterprise capability. If corporate finance can be viewed as a competency on the same level as other nonfinancial competencies (e.g., organizational competency, R&D competency, and strategic competency), then it includes any intrinsic financial competencies that contribute to these disclosed financial performance. This is a general view of a company's financial strength. Many researchers support a broad view of a firm's financial capability and examine what constitutes a firm's financial capability. Corporate financial capabilities mainly include corporate financial performance capabilities, financial work

capabilities, and financial management capabilities. Among them, financial performance capability is the capability that clearly reflects the financial performance of an enterprise, such as profitability and solvency, and corporate finance and other financial business functions. Financial management capabilities, such as organizational coordination capabilities, such as financial capabilities, corporate financial capabilities include the company's financial operation capabilities, financial management capabilities, adaptability, and financial performance capabilities.

2.2. The Narrow View of Corporate Financial Capability. The narrow view of corporate financial capabilities holds that no matter how specific financial capabilities are subdivided, other financial capabilities will eventually manifest as explicit financial performance capabilities, mainly referring to the financial performance capabilities of enterprises. Regarding the composition of corporate financial performance capabilities, the current research mainly includes three classification methods: "three-point method", "four-point method", and "five-point method". The "rule of thirds" taxonomy generally divides a company's financial strength (performance) into profitability, solvency, and operating strength. The "quartile method" is a commonly used classification method. Generally speaking, the financial strength of an enterprise is divided into four categories: profitability, solvency, operating ability, and development ability (growth). It is a capability dimension that reflects the sustainable development of an enterprise and company. The conclusions of the "five points" classification are not uniform in related studies. The financial strength of a business can be divided into profitability, solvency, operating capacity, growth capacity, and creativity; some researchers believe that profitability, safety, productivity, growth, and activity reflect the ability to evaluate financially and business performance.

2.3. The Measurement of Corporate Financial Capability. With the development of related research, in addition to discussing theoretical issues such as the connotation, composition, and theoretical framework of corporate financial capabilities, the research on the measurement of corporate financial capabilities has also received more and more attention, especially with the emergence of relevant empirical research. Measuring a firm's financial capability directly affects the reliability of empirical research conclusions. To sum up, in the current research, there are two main methods to measure the financial strength of a company: the single indicator method and the comprehensive indicator system method.

2.3.1. Single Index Method. The single indicator method is a measurement method that directly uses a single financial indicator of the enterprise to measure the corresponding financial strength of the enterprise or selects several financial indicators without establishing an indicator system, and systematically distributes the composition of the company's financial status. It is relatively simple and convenient to measure the financial strength of enterprises with the single indicator method, but due to the complexity and comprehensiveness of the financial strength of enterprises, the comprehensiveness of this method is poor. According to the specific research objectives, when it is not necessary to comprehensively consider all the financial capabilities of the enterprise, but only the most important aspects, the single indicator method is used to measure the financial capabilities of the enterprise.

2.3.2. Comprehensive Index System Method. The comprehensive index system method is a general evaluation method. It selects several financial indicators and establishes an index system to measure the financial strength of enterprises through certain scientific methods. The comprehensive index system method uses a variety of financial indicators to combine the measurement of each component of the enterprise's financial status, which can comprehensively evaluate the actual status of the enterprise's financial status, and is widely used in the study of the enterprise's financial status.

3. Enterprise Financial Risk Prediction under Big Data

3.1. Calculation Framework for Corporate Financial Uncertainty. First, define $y_{jt}, Y_t\,(y_{Ir}, y_{2t}, L, y_{nt})$ as the set of economic variables that observe the financial uncertainty of the enterprise in period t, and define $U_{jt}^{y}(h)$ as the set of conditional fluctuations based on the sequence of economic variables in period t to predict the unpredictable part of the future $t+h$ period, namely,

$$U_{jt}^{y}(h) = \sqrt{E\left[y_{jt+h} - E\left(y_{jt+h}I_t\right)\right]^2}. \tag{1}$$

Among them, $j = 1, 2, L, N$; I_t represents the data information of the t period; $E(I_t)$ is the conditional period based on the data information of the t period seen. After calculating the uncertainty of a single variable, add up the uncertainty of the overall sequence at the same time point to obtain the financial uncertainty of the company at that time point, which can be expressed as follows:

$$U_t^{y}(h) = p\lim_{N_Y} a_{j=1}^{N_y} w_j U_{jt}^{y}(h). \tag{2}$$

Among them, w_j represents the weight of j economic variables in the economic series.

In order to obtain the overall financial uncertainty of the enterprise, it is important to measure $E(y_{jt+h}I_t)$ based on the data information of the t period. In order to obtain the predicted value, first consider a set of predictors based on the overall sample data. $\{X_{it}\}$ factor model is used to extract the common factors between variables, where a stationary data set $X_t = (X_t, X_{2t}, L, X_{nt})$ is defined, and it is assumed that X_t has a factor structure of the form as

$$X_{it} = U_i^F F_t e_{it}^X. \tag{3}$$

In the formula, F_T is the common factor of dimension r_F 1; U_i^F is the factor loading matrix of F, which is dimension r_F 1; e_{it}^X is the random error vector of F. In this factor structure, the random error vector can have limited cross-sectional correlation, and the number of factors must be significant and less than the number of variables.

Assuming that $y_{jt}Y_t(y_{1t}, y_{2t}, \ldots, y_{nt})$ is the target uncertainty sequence, the value of $t+h$ is estimated by the following model:

$$y_{jt+h} = f_j^y(L)y_{jt} + g_j^F(L)F_t + g_j^w(L)W_t + v_{jt+h}^y. \quad (4)$$

At the same time, because the factors have autoregressive characteristics of time-varying characteristics, the model can be expressed as an extended factor vector autoregressive model. Therefore, the prediction of the $t+h$ period based on the t period sequence can be obtained through this model, namely,

$$\begin{pmatrix} Z_t \\ Y_{jt} \end{pmatrix} = \begin{pmatrix} \Phi^z & 0 \\ \wedge_j & \Phi_j^Y \end{pmatrix} \begin{pmatrix} Z_{t-1} \\ Y_{jt-1} \end{pmatrix} + \begin{pmatrix} v_t^Z \\ v_{jt}^Y \end{pmatrix}, \quad (5)$$
$$y_{jt} = F_j^Y y_{jt-1} + v_{jt}^y,$$

where U_j, U_j is the coefficient function of the lag term of y_{jt-1}, and the maximum eigenvalue of F_j^Y. If the maximum eigenvalue of F_j^Y is less than 1, the characteristic polynomial of the matrix can calculate all the eigenvalues of the matrix, and the largest one is the maximum eigenvalue of the matrix. We can calculate the characteristic root according to Equation (5), and this condition needs to be satisfied which is required to be less than 1, so the predicted expected value of the $t+h$ period is

$$E\left(y_{jt+h}\right) = \left(F_j^Y\right)^h y_{jt}. \quad (6)$$

At this point, the forecast error based on period t is

$$W_{jt}^y(h) = E_t\left[\left(y_{jt+h} - E_t y_{jt+h}\right)\left(y_{jt+h} - E_t y_{jt+h}\right)\right]. \quad (7)$$

The estimated error prediction value based on the matrix can be expressed as follows:

$$W_{jt}^y(h) = E_t\left[\left(y_{jt+h} - E_t y_{jt+h}\right)\left(y_{jt+h} - E y_{jt+h}\right)\right]. \quad (8)$$

Therefore, the uncertainty of a variable at time t can be expressed as follows:

$$U_{jt}^y(h) = \sqrt{1_j W_{jt}^y(h) 1_j}. \quad (9)$$

The overall corporate financial uncertainty can be obtained by weighting the univariate and expressed as follows:

$$U_t^y(h) = a_{j=1}^{N_y} w_j U_{jt}^y(h). \quad (10)$$

The weighting method can be based on principal component analysis to extract the weights of different economic variables, or it can be weighted by simple arithmetic average, so that the financial uncertainty of the enterprise can be obtained.

3.2. Establishment of Financial Risk Prediction Model. The quadratic exponential smoothing analysis method in the exponential smoothing model is very suitable for financial data with periodicity. The smoothing model also has certain shortcomings. We need to adjust the exponential smoothing. The second exponential smoothing method is a method of performing another exponential smoothing on an exponentially smoothed value. It cannot be predicted alone, and must be combined with an exponential smoothing method to establish a mathematical model for prediction, and then use the mathematical model to determine the predicted value. The two limiting factors of the primary moving average method only exist in the linear quadratic moving average method, the linear quadratic exponential, and the smoothing method can be calculated using only three data and one a value; Like to use linear quadratic exponential smoothing as a forecasting method. Coefficient: first, the rising and falling trends of the original data cause the forecast results to lag behind. The actual value; secondly, the most important factor for the success of exponential smoothing forecast is the smoothed value. The selection of traditional smoothing coefficients is based on empirical judgment. When choosing a smoothing value, the smoothing value should be determined when the error is minimal.

First, the smoothing coefficient is determined by the MAE method. Find the expected value with the smallest difference from the actual value, which is the smoothing coefficient, as shown in formula as follows:

$$MAE(\text{best\_}a) = \text{Min\_}MAE = \frac{1}{t}\sum_{i=1}^{t}\left|Y^i - y^i\right|. \quad (11)$$

In the above formula, $MAE(\text{best\_}a)$ represents the MAE value corresponding to the optimal smoothing value, and Min_MAE represents the minimum value of MAE.

The second step is to substitute the best_a value into the quadratic exponential smoothing model to calculate $S^{(1)}, S^{(2)}, Yi$, as shown in the following formula:

$$\begin{aligned} S_t^{(1)} &= (\text{best\_}a)y_t + [1 - (\text{best\_}a)]S_{t-1}^{(1)}, \\ S_t^{(2)} &= (\text{best\_}a)S_t^{(1)} + [1 - (\text{best\_}a)]S_{t-1}^{(2)}. \end{aligned} \quad (12)$$

From this, the primary and secondary smoothing values corresponding to the optimal smoothing coefficient a can be calculated. In the third step, substitute the values of $S_t^{(1)}$ and $S_t^{(2)}$ into the following formulas:

$$a_t = 2S_t^{(1)} - S_t^{(2)}, \quad (13)$$

$$b_t = \frac{a}{1-a}\left(S_t^{(1)} - S_t^{(2)}\right). \quad (14)$$

Finally, substitute a_t and b_t into the following formula:

$$Y_{t+T} = a_t + b_t \bullet T. \quad (15)$$

To sum up, the whole process of establishing the calculation model is as follows: the global configuration of the java deployment environment; the construction of the quadratic exponential smoothing method, and the establishment of the minimum error adjustment curve, including the data of 35 periods of financial indicators. Financial risk is

one of the biggest risks it often faces in manufacturing and operating activities, and it has drawn the attention of business leaders. The company's operating ability, profitability, and solvency are the three most important elements in financial risk analysis. Among them, credit has the highest influence coefficient on financial risks. Credit status can also help enterprise managers to objectively analyze the current risk situation and effectively make business decisions. Financial risks based on solvency and entrepreneurs, owners, interests of creditors, and other parties. Therefore, when choosing research indicators, this paper divides the repayment ability into two levels: short-term and long-term.

3.2.1. Short-Term Level. The ability of inventory to repay current liabilities on time represents the level of repayment of a company's current liabilities and is considered very important by investors, creditors, and management. The data indicators to measure the short-term debt service level of a company are the current ratio and the quick ratio. The formulas for calculating the current ratio and quick ratio are as follows:

$$\text{current ratio} = \frac{\text{total current assets}}{\text{total current liabilities}} \times 100\%,$$
$$\text{quick ratio} = \frac{\text{total liquid assets}}{\text{total current liabilities}} \times 100\%. \tag{16}$$

Formula: quick ratio = (total current assets - inventory)/total current liabilities; conservative quick ratio = 0.8 (monetary funds + short-term investment + notes receivable + net accounts receivable)/current liabilities; standard set by the enterprise Value: 1; Significance: It is a better indicator of the company's ability to service short-term debt than the current ratio. Because current assets include inventories that are slow to realize and may have depreciated, current assets are deducted from inventories and then compared with current liabilities to measure the short-term solvency of the company. Analysis Tip : A quick ratio below 1 is generally considered to be low short-term solvency. An important factor that affects the credibility of the quick ratio is the liquidity of accounts receivable. The accounts receivable on the book may not be able to be realized, nor may they be very reliable.

3.2.2. Long-Term Level. A company's ability to repay its long-term debt on time is its long-term creditworthiness. An important indicator that can quantify a company's long-term debt repayment level is the asset-liability ratio, which refers to the ratio of a company's debt to its assets, as well as a company's debt ratio per dollar. The formula looks like this:

$$\text{assets and liabilities} = \frac{\text{total liability}}{\text{total assets}} \times 100\%. \tag{17}$$

The passivity of a company's assets is negatively related to its long-term solvency. In addition to the asset-liability ratio, a data indicator to quantify a company's long-term solvency is the equity ratio. The owner's share of the investment in the company's assets is called the equity ratio.

$$\text{Shareholders' equity ratio} = \frac{\text{shareholders' equity}}{\text{total assets}} \times 100\%. \tag{18}$$

4. Enterprise Financial Risk Prediction and Prevention

The financial status of an enterprise can present the financial risk situation of the enterprise. Therefore, it is necessary to analyze the financial status of the enterprise first to understand the current financial status, operating results, and cash flow of the enterprise, so as to pave the way for subsequent risk assessment. Take the financial situation of the company as an example to conduct surveys to better obtain data to study the business situation of enterprises and make risk predictions.

4.1. Balance Sheet Analysis. As can be seen from Table 1, the proportion of current assets of the company has increased year by year, from 41.07% in 2018 to 50.61% in 2020, and the proportion of non-current assets of the company has decreased year by year, from 58.93% in 2018 to 2020 of 49.39%. It can be seen that the asset structure of the company has undergone major changes in the past three years, from non-current assets accounting for more than 50% to current assets accounting for more than 50%, which shows that the elasticity of the company's assets has increased year by year.

The proportion of current assets in the industry has increased year by year, from 56.14% in 2018 to 57.62% in 2020. The proportion of non-current assets in this company has decreased year by year, from 43.86% in 2018 to 42.38 in 2020. It can be seen from Tables 1 and 2 that the proportion of current assets in the industry in the three years from 2018 to 2020 remained between 56% and 58%, which was higher than that of the surveyed companies. It can be seen that compared with the same industry, the elasticity of the company's assets is poor.

To sum up, compared with the same industry, the elasticity of the company's assets is poor, but there has been a trend of increasing year by year, and the company's asset structure is gradually developing towards the proportion of the industry's asset structure.

4.2. Analysis of Funding Sources. Because the total liabilities and owner's equity in Table 3 are increasing year by year, one of them indicates negative assets and the other indicates positive assets, so it is not easy to judge the overall operation of the enterprise. Generally, we analyze the proportion of both increases at the same time. In positive assets if the increase is more, the business condition of the company is good, otherwise it is not good. The positive assets of the pharmaceutical company in the particles in the article, that is, the owner's equity, have increased more, so the business situation of the company has improved in the past three years.

From Table 3, we can see that the proportion of current liabilities of the company has gradually decreased from

Table 1: Asset structure of an enterprise.

Project	2018	Constitute (%)	2019	Constitute (%)	2020	Constitute (%)
Current assets	73.5796.05	41.07	778677.15	42	1211128.91	50.61
Non-current assets	1055885.69	58.93	1075441.98	58	1182042.76	49.39
Total assets	1791681.74	100.00	1854119.13	100.00	2393171.67	100.00

Table 2: Average asset structure of the same industry.

Project	2018	Constitute (%)	2019	Constitute (%)	2020	Constitute (%)
Current assets	18478.9	56.14	19310.7	57.00	21673.5	57.62
Non-current assets	14434.2	43.86	14565.1	43.00	15938.7	42.38
Total assets	32913.1	100	33875.8	100	37612.2	100

Table 3: The source of funds of an enterprise.

Project	2018	Constitute (%)	2019	Constitute (%)	2020	Constitute (%)
Current liabilities	1070761.95	59.76	1008040.90	54.37	1175332.61	49.11
Non-current liabilities	169716.42	9.47	283672.84	15.30	512282.51	21.41
Total liabilities	1240478.37	69.24	1291713.74	69.67	1687615.12	70.52
Total owner's equity	551203.37	30.76	562405.39	30.33	705556.56	29.48
Total liabilities and owners' equity	1791681.74	100.00	1854119.13	100.00	2393171.67	100.00

59.76% in 2018 to 49.11% in 2020; the proportion of current liabilities has increased year by year, from 9.47% in 2018 to 21.41% in 2020%; the proportion of total liabilities has also increased year by year, from 69.24% in 2018 to 70.52% in 2020; the total proportion of owners' equity has decreased year by year, from 30.76% in 2018 to 29.48%. The total value of liabilities and owners' equity has increased year by year, from 17,916,817,400 yuan in 2018 to 23,931,716,700 yuan in 2020.

From Table 4, we can see the average assets and liabilities of the same industry. In 2018, the total liabilities averaged 137.447 million yuan, which increased year by year in the following two years. In 2020, the total liabilities reached 152.918 million yuan; in 2018, the total assets were 329.131 million yuan, which increased year by year in the following three years. By 2020, it will reach 376.122 million yuan; the asset-liability ratio has dropped from 41.76% in 2018 to 40.66% in 2020. Although liabilities are rising year by year, assets are also rising year by year and the ratio is faster than the total liabilities, so the asset-liability ratio will decrease year by year during 2018–2020.

From the comparison of Tables 3 and 4, it can be seen that the proportion of debt financing of the company is very high. From 2018 to 2020, the proportion of debt financing is between 69% and 71%, and it has maintained a growth trend in the past three years. However, in the past three years, the industry's asset-liability ratio has only remained between 40% and 42%, and it has maintained a downward trend in the past three years. This shows that in the same industry, the comprehensive strength of the company to repay debts is relatively poor, and the financial risk is relatively high. In addition, the proportion of current liabilities in the company's debt financing from 2018 to 2020 is much higher than that of the non-current liabilities, indicating that the company's short-term debt repayment pressure is very high.

Table 4: Assets and liabilities of the industry.

Project	2018	2019	2020
Total liabilities	13744.7	13970	15291.8
Total assets	32913.1	33875.8	37612.2
Assets and liabilities	41.76%	41.24%	40.66%

4.3. Identification of External Financial Risks. In corporate finance, there are not only internal corporate financial risks caused by insufficient capital flow, personnel changes, and changes in decision-making, but also external financial risks are huge hidden dangers, such as: policy change risks (because we are investigating the pharmaceutical industry as an example, here the pharmaceutical industry has also been taken as an example.) For example, with the reform and development of my country's pharmaceutical industry and the continuous introduction of industrial support policies, the prices of pharmaceutical products have continued to decline. At the same time, the implementation of policies such as drug registration, review, approval process optimization and consistency evaluation, and "4 + 7" volume procurement have changed the business model of pharmaceutical companies, making the pharmaceutical manufacturing industry face both opportunities and challenges and operating environmental risks. In recent years, the continuous improvement of environmental protection standards and increasingly strict drug quality supervision have made the original. The investment in materials, energy, labor costs, and environmental protection is constantly increasing. At the same time, raw materials, prices for labor, transportation, etc., are also rising. These factors have greatly increased the cost of enterprises and limited the growth of profits. In addition, the new crown pneumonia epidemic in 2020 has caused domestic production and business closures, most companies suffered heavy losses in the first quarter,

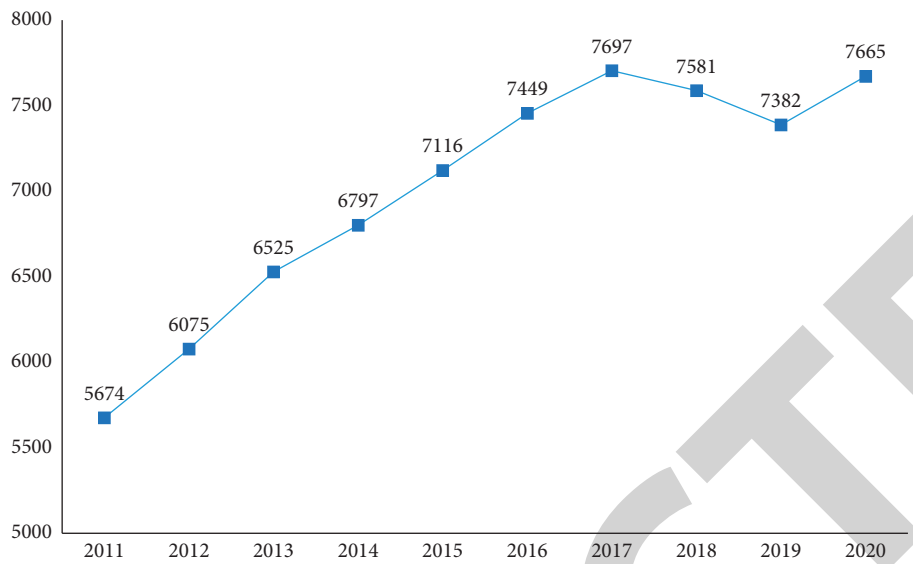

Figure 1: Number of companies in the pharmaceutical manufacturing industry from 2011 to 2020.

and some companies went bankrupt. In such a harsh external environment, companies and individuals are reducing purchases and consumption, the operating environment is very risky, and the fierce competition in the industry will also affect the external financial situation. We have investigated the industry competition of the pharmaceutical company as shown in Figure 1.

The data in Figure 1 shows the number of pharmaceutical manufacturing companies from 2011 to 2020. It can be seen that from 2011 to 2017, it increased steadily year by year, reached its peak in 2017, and then slightly decreased in 2018 and 2019, and then resumed in 2020. Back to the peak, from 2011 to 2017, with the development of the times, people paid more attention to health care, so the number of pharmaceutical companies continued to increase, and the competition became more and more fierce. In 2019, the pharmaceutical industry tends to be saturated and slightly down. In 2020, with the advent of the epidemic, the emphasis on medicine will be more extensive, so the number of pharmaceutical industry enterprises has reached a peak again.

As can be seen from Figure 1, the number of pharmaceutical manufacturing enterprises in the ten years from 2011 to 2020 showed an overall growth trend, from 5,674 enterprises in 2011 to 7,665 enterprises in 2020. In the past decade, new companies have continued to join to seize the market share. By 2020, more than 7,000 companies will compete together, resulting in increasingly fierce market competition in the pharmaceutical manufacturing industry.

4.4. Internal Financial Risk Identification

4.4.1. Analysis of Financing Methods. The main investment methods of enterprises in my country include bank loans, issuance of stocks, and issuance of bonds.

From Table 5, it can be seen that the company has a variety of financing methods. In 2016 and 2017, it mainly used borrowing, issuing bonds and other financing activities for financing. In 2018, it mainly used to absorb investment, borrowing, issuing bonds and other financing activities for financing. In 2019 and 2020 mainly through the absorption of investment, borrowing and other financing activities for financing. It is worth noting that from 2016 to 2020, the company raised funds by borrowing every year, and the amount of funds raised was huge. It can be seen that the internal financing structure in the financing method is unreasonable, and the annual increase in cash paid for debt repayment will continuously increase the financing cost, which will lead to the increase of financing risk.

4.4.2. Debt Maturity Structure Analysis. A company's debt maturity structure refers to the quantitative relationship between the company's long-term and short-term debts. An unreasonable debt maturity structure will increase the financing risk faced by the company. Due to the fast short-term debt maturity, if the short-term debt ratio is high and the maturity is concentrated, it will be difficult to repay the capital flow; due to the high interest rate of the long-term debt, if the long-term debt ratio is high and the maturity is concentrated, there will be high interest expenses, and it may face the risk of financial rupture.

From Table 6, it can be seen that from 2016 to 2020, the current liability ratio of the pharmaceutical company is very high, with a minimum value of 69.64%. It can be seen that the pharmaceutical company mainly uses short-term funds when using debt funds. Although this can reduce the cost of debt for enterprises, it requires high liquidity of assets. The liquidity of assets is generally reflected by the current ratio and the quick ratio. Generally, the current ratio is greater than or equal to 2, and the liquidity of the asset is higher when the quick ratio is greater than or equal to 1. However, from 2016 to 2020, the current ratio and quick ratio of the company did not meet the general standards. It can be seen that its asset liquidity is poor. Therefore, the short-term debt

Table 5: Changes in the company's financing (unit: ten thousand yuan).

Project	2016	2017	2018	2019	2020
Absorbed cash received from investments	0.00	0.00	10104.00	105800.00	136006.00
Get cash received from borrowing	447270.00	655287.00	724418.80	993979.68	1497125.84
Cash received from bond issuance	199800.00	199229.00	99700.00	0.00	0.00
Receive other cash related to fundraising activities	39200.00	56750.00	26768.12	138616.45	43832.43
Subtotal of cash inflows from financing activities	686270.00	911266.00	860990.92	1238396.14	1676964.27

Table 6: Debt maturity structure of the pharmaceutical company (unit: ten thousand yuan).

Project	2016	2017	2018	2019	2020
Current liabilities	910678.12	869517.50	1070761.95	1008040.89	1175332.61
Total liabilities	1118497.49	1187092.70	1240478.37	1291713.74	1687615.12
Current liability ratio	81.42%	73.25%	86.32%	78.04%	69.64%
Current ratio	0.74	0.78	0.69	0.77	1.03
Quick ratio	0.57	0.58	0.49	0.56	0.82

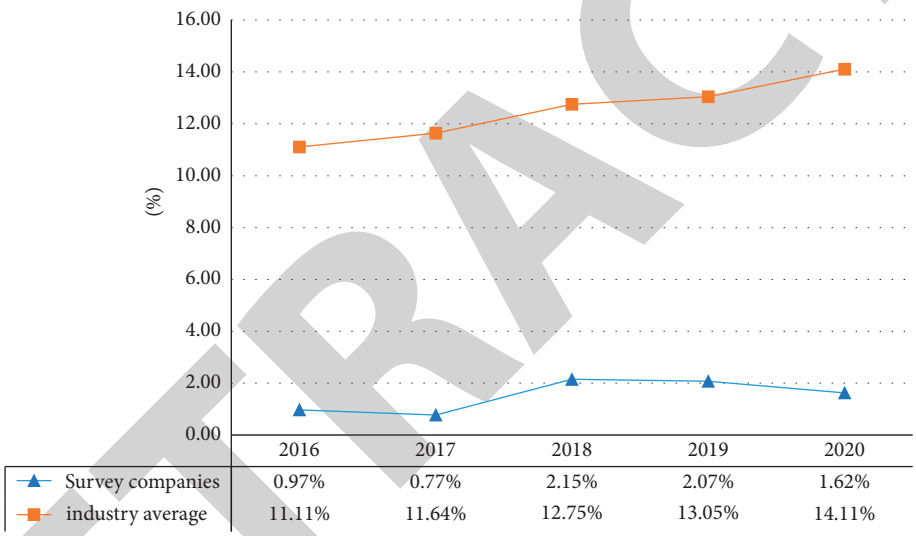

Figure 2: Investigate the sales profit margin of pharmaceutical companies and pharmaceutical manufacturing industries.

repayment pressure of the enterprise is relatively high, and the financial risk is relatively high.

4.4.3. Analysis of Sources of Debt Repayment. Profits from business activities are the main source of debt repayment.

As can be seen from Figure 2, the sales profit margin of the pharmaceutical company is significantly lower than that of the pharmaceutical manufacturing industry. From 2016 to 2020, the sales profit margin of H pharmaceutical companies has been lower than 3% and increased first and then decreased. In 2020, it dropped from the highest value of 2.15% to 1.62%. From 2016 to 2020, the sales profit margin of the pharmaceutical manufacturing industry was higher than 10% and showed an increasing trend, rising from 11.11% in 2016 to 14.11% in 2020. Therefore, under the influence of the new crown pneumonia epidemic at the same time, the sales profit margin of the surveyed pharmaceutical company is significantly lower than that of the pharmaceutical manufacturing industry, which shows that the pharmaceutical company's sales profitability is poor and there is a risk of debt repayment.

4.4.4. Inventory Risk Analysis. From Table 7, it can be seen that from 2016 to 2020, the pharmaceutical company's inventory showed an overall growth trend, from 1,502,323,200 yuan in 2016 to 2,452,923,400 yuan in 2020, indicating that the company's investment in inventory is increasing year by year. In addition, except for the inventory growth rate of -12.86% in 2016, the inventory growth rate of the surveyed pharmaceutical companies from 2017 to 2020 was all positive, indicating that the pharmaceutical company has a backlog of inventory. As can be seen from Figure 3, from 2016 to 2020, the proportion of the pharmaceutical company's inventory to current assets increased first and then decreased, from 22.44% in 2016 to 28.51% in 2019, and then to 20.25% in 2020. The mean changes tend to be roughly the same. Moreover, except for the proportion of the pharmaceutical company's inventory in current assets in 2020, which

Table 7: Inventory of the pharmaceutical company.

Project	2016	2017	2018	2019	2020
Stock	150232.32	173138.71	207367.61	221973.14	245292.34
Inventory growth rate	−12.86%	15.25%	19.77%	7.04%	10.51%
Inventory/current assets	22.44%	25.40%	28.18%	28.51%	20.25%

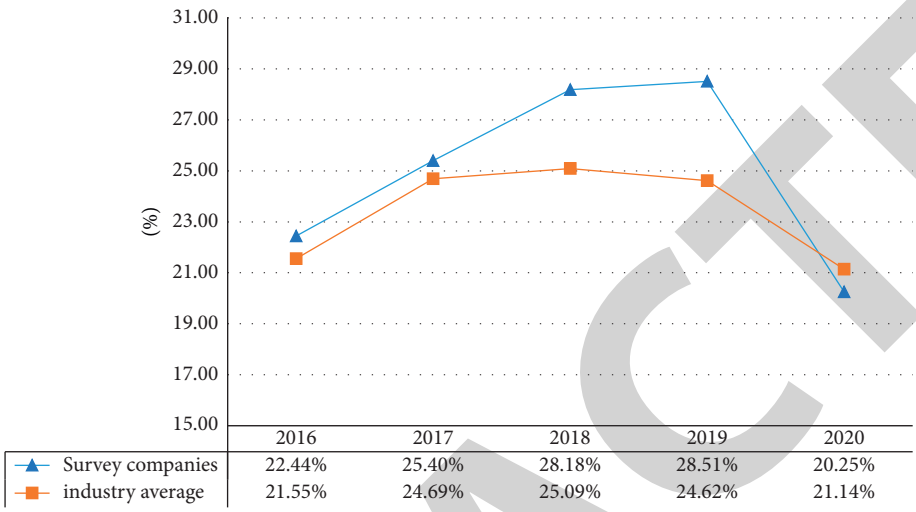

Figure 3: The ratio of inventories to current assets in the surveyed pharmaceutical companies and industries.

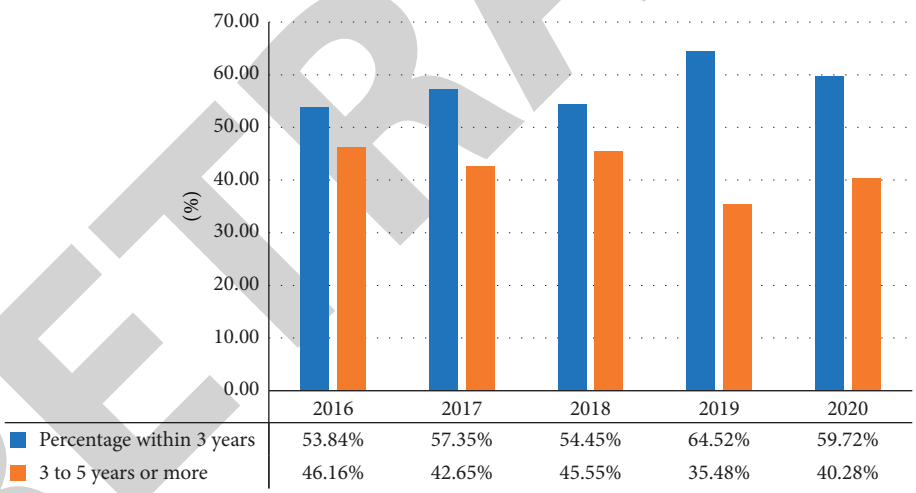

Figure 4: Investigate the aging of accounts receivable of pharmaceutical companies.

was slightly lower than the industry average, all other years were higher than the industry average, which shows that the proportion of the pharmaceutical company's inventory in current assets is high, and there is a backlog of inventory.

4.4.5. Accounts Receivable Analysis. As can be seen from Figure 4, from 2016 to 2020, the proportion of the pharmaceutical company's accounts receivable aged 3 to 5 years fluctuated, the lowest value was 35.48% in 2019, the highest value was 46.16% in 2016, and from 2019 to 2020, it showed an increasing trend, reaching 40.28%. Because the longer the account age, the less likely the receivables will be recovered. In addition, in the 5 years from 2016 to 2020, 4 of the accounts receivables aged 3 to 5 years accounted for more than 40%. It can be seen that there is a great risk in the collection of accounts receivable of the pharmaceutical company.

Accounts receivable turnover is the amount the business is owed, and it is an important factor in a business's financial health. The industry's highest accounts receivable in 2018 also indicates that the industry developed very well in 2018. In 2020, this data in the same industry is rising, while the surveyed companies are declining, which indicates that the surveyed companies have problems in their operations this year, the company's financial situation needs to be treated with caution.

From Figure 5, it can be seen that from 2016 to 2020, the accounts receivable turnover rate of H pharmaceutical companies generally increased first and then decreased,

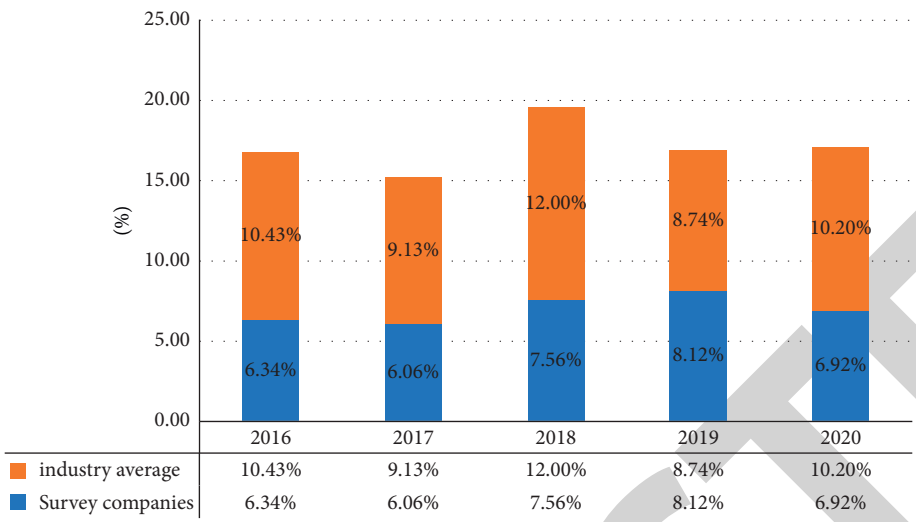

Figure 5: Analysis of accounts receivable turnover ratio of the pharmaceutical enterprise and pharmaceutical manufacturing industry.

especially in 2020, it dropped to 6.92%. It can be seen that in 2020, the collection of accounts receivable of the pharmaceutical company will deteriorate. From 2016 to 2020, the accounts receivable of the pharmaceutical manufacturing industry showed fluctuations, but in 2020, it rose to 10.2%. It can be seen that the recovery of accounts receivable in the pharmaceutical manufacturing industry will improve in 2020. In general, from 2016 to 2020, the accounts receivable turnover rate of the pharmaceutical company was significantly lower than that of the pharmaceutical manufacturing industry. It can be seen that compared with the industry, it is difficult to recover the accounts receivable of the pharmaceutical enterprises under investigation, and there is a greater risk.

After investigation and comparison with the same industry, we can predict the risks of the investigated pharmaceutical companies, and the companies have greater risks.

4.5. Enterprise Financial Risk Prevention. Enterprise financial risk prevention has many advantages, which is helpful for investors to invest; it helps management to strengthen internal control; it helps to improve the financial situation of enterprises. We also conducted a survey on the preventive measures of corporate financial risks. The survey results are as follows in Figure 6:

After our investigation of the four major corporate financial risk prevention methods currently used (1) to analyze the financial management environment, the audience of this method accounts for 20%. (2) Improving the scientific level of decision-making, this method accounts for 30% of the audience. (3) Risk transfer method: the audience of this method reaches 40% at most. (4) Diversified risk control method accounts for 10%. These methods can better help us prevent risks.

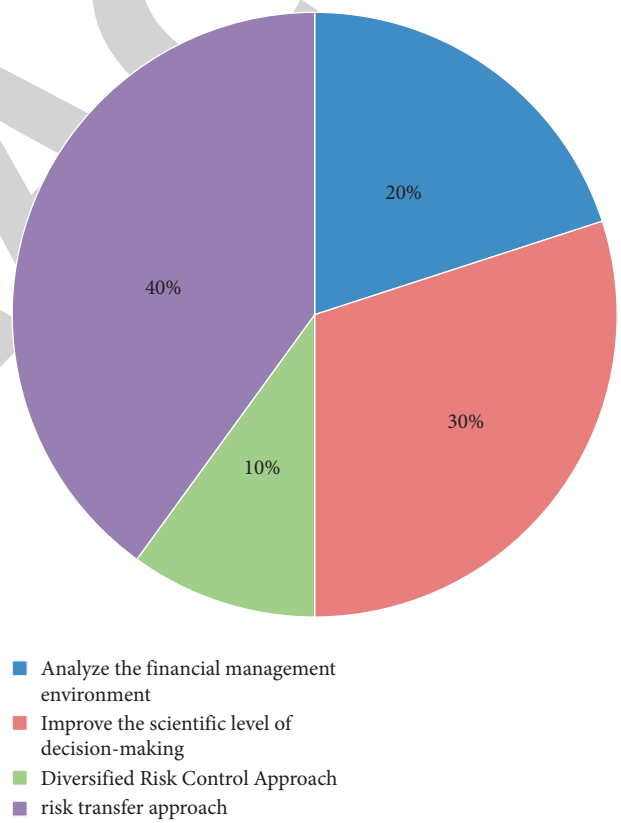

Figure 6: The proportion of the audience of risk prevention methods.

4.6. The Impact of Big Data on Corporate Finance. After the emergence of modern scientific and technological achievements such as the Internet of Things and cloud computing, a new technological change has emerged in today's world, that is, big data, which has had an extraordinary impact on various fields. The development direction of corporate financial management in the era of big data includes: cultivating the big data management awareness of corporate decision-makers, transforming corporate financial management functions, improving the level of financial management informatization construction, promoting the transformation of financial analysis from post-event

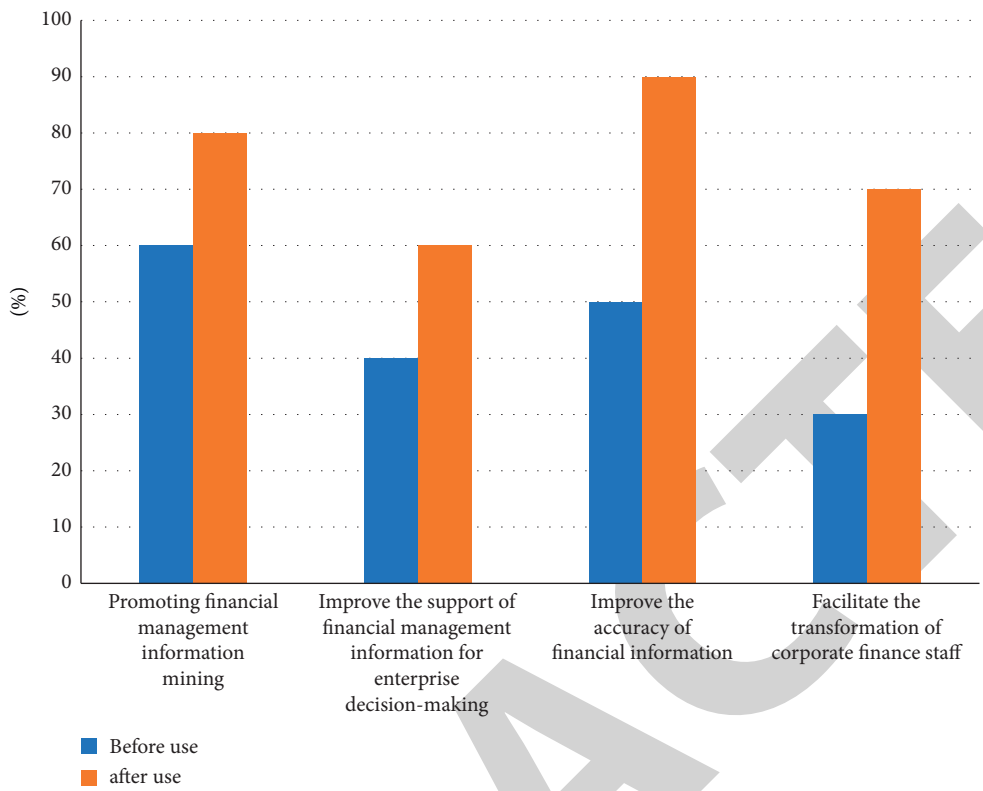

Figure 7: Comparison of progress in various aspects after using big data.

reflection to in-process control, and building large-scale financial management systems, and data finance talent team. In-depth analysis of the impact of big data on corporate finance will find that in the eyes of workers, the impact is roughly in the following aspects, as shown in Figure 7.

After the use of big data, many aspects of corporate finance have improved. After the survey, it was found that the improvement in the accuracy of financial information after application has increased to 90%, and the promotion of information mining has increased by 20%, increasing the influence of corporate finance on corporate decisions. A 20% increase and a 40% increase in the promotion of personnel transformation. Progress in all aspects can make the financial situation of the enterprise better, which is conducive to the reduction of risks. From this, it can be seen that the prediction and prevention of corporate financial risks under big data can improve efficiency and better prevent them.

5. Conclusion

This paper makes an in-depth study on the prediction of enterprise financial risk under big data. Corporate finance controls the lifeblood of corporate development and survival. We have analyzed the concept of corporate finance and better understand the definition of corporate finance. In the era of big data, we can better collect corporate financial data for risk assessment. The algorithm of financial risk assessment also better maintains the development of the enterprise and calculates the financial risk more quickly. The pharmaceutical enterprise in the example comprehensively demonstrates the enterprise risk assessment.

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 author declares that there are no conflicts of interest regarding this work.

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Retraction

Retracted: A Recommended Approach to Classical Literature and Art Exhibition Activities Oriented towards Interactive Modelling

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. He and Y. Li, "A Recommended Approach to Classical Literature and Art Exhibition Activities Oriented towards Interactive Modelling," *Security and Communication Networks*, vol. 2022, Article ID 5491714, 9 pages, 2022.

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Research Article

A Recommended Approach to Classical Literature and Art Exhibition Activities Oriented towards Interactive Modelling

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Chinese classical literature and art exhibition activities have a special role to play in improving the humanities of students. Introducing elements of classical literature into cultural activities can effectively complement the current humanities education in universities. To improve the efficiency and intelligence of classical literature and art exhibition activities, this paper proposes an interactive modelling-oriented method for recommending classical literature and art exhibition activities in response to the characteristics of existing art exhibition event management systems (AEEMS) in supporting process modelling and the interactive modelling needs of audiences. By using exhibition event segments as the recommended reference model, the process includes steps such as data preprocessing and calculating the matching degree and can recommend reasonable classical literature art exhibition events based on the art exhibition model under construction and the modelling needs of the audience. Experimental data are obtained by using a questionnaire survey method, and the experimental results show that it outperforms existing methods in terms of evaluation indicators such as accuracy, recall, and F_1, indicating the effectiveness of the proposed method.

1. Introduction

In the 21st century, China has entered a period of rapid economic and social development, and higher education has also entered a period of comprehensive development [1, 2]. The comprehensive and universal development of higher education has certainly played a great role in promoting social development and economic prosperity, but the problems in the development should not be ignored. On the one hand, with the expansion of higher education, students of all quality levels may be absorbed into higher education, which makes the quality of students vary. In order to promote the all-round development of students, we need to update the educational philosophy and teaching methods of colleges and universities in a timely manner and at the same time attach importance to the teaching of scientific knowledge, so that the teaching methods can keep pace with the times.

In the current cultural activities of universities, academic and scientific competitions are in full swing, but cultural activities with humanistic qualities are less organized. Even if they are organized, it is difficult to make them a high standard and high-level cultural feast, so that they have to absorb elements of popular and popular literature to attract audiences, in order to achieve the effect of pandering to the vulgar. Chinese classical literature has developed over thousands of years [3, 4] and has left behind countless glorious and great classics, which are models of Chinese language and art.

In the history of classical Chinese literature, both the writers and the themes of their works advocate the cultivation of a noble and realistic ideal of active initiation into the world and celebrate the spirit of enterprise that is indefatigable in order to achieve it. The persistent pursuit of lofty ideals that permeates classical literature has positive significance for the humanistic education of contemporary

university students. When college students encounter difficulties and setbacks, it is easy to lack the support of their ideals and beliefs. Instead of working hard to overcome difficulties and meet challenges, they should rise to the challenge and believe in themselves.

The theme of shaping the national spirit is even more prevalent in classical literature. The theme of patriotism has been a constant and deafening cry throughout the history of classical literature. In the face of the tragic reality, literature is full of voices expressing national spirit and patriotic fervour. In today's globalised economy and world integration, international competition is still a war without smoke and mirrors, and it is inevitable to strengthen patriotic education for university students [5, 6]. The introduction of classical literature into the construction of university cultural activities can not only overcome students' aversion to ideological and political theoretical preaching, but also play a good educational role. Cultural and artistic activities [7] are an important platform for teachers and students to exchange and interact, learn from each other, and demonstrate campus culture. Although almost all universities offer courses on ancient literature, a few courses are far from enough to meet the needs of students' quality education. The absence of classical literature in the cultural and artistic activities of contemporary universities is a pity, and this situation must be changed.

The introduction of classical literary elements into the performance of cultural and artistic events. When it comes to art programmes in universities [8], they are often popular in the form of singing, dancing, sketches, and comedy, but the content is also full of modern popular elements. If it is possible to introduce modern popular elements into campus cultural activities, it is inevitable that classical literary elements can also be introduced. Universities can organise seminars on classical literature through academic departments or student groups. Classics teachers can organise lectures on a variety of topics, so that students are free to choose their own studies according to their interests. By organising these high-level cultural activities, the university will continue to enrich and enrich the content of its cultural activities, expand student-to-student exchanges, and cultivate students' interest in revering classical culture as well as their innovative spirit.

Universities can organise large scale classical culture and arts festivals, combining classical literature with modern university festivals. It is well known that classical culture and arts are composed of different small modules. In colleges and universities, this feature allows teachers and students to participate according to their interests, thereby promoting a close relationship between students and teachers. Such activities improve students' classical culture and also enrich the cultural life of teachers and students, such as classical drama appreciation activities and classical poetry recitation activities, creating a strong classical cultural atmosphere on campus. This will help students to develop a healthy aesthetic and psychological personality and will greatly enhance their classical literacy.

In recent years, with the widespread use of AEEMS, a large number of recommended models for art exhibition events have been collected in online platforms such as myExperiment, CrowdLabs, and SHIWA [9]. Although these platforms provide functions such as keyword search to facilitate sharing, reusing, or repurposing the models. However, it is still challenging to derive valuable information from these models to aid modelling. Moreover, unlike other models, researchers in AEEMS applications need to improve the model based on the current execution of the model, such as modifying the activity nodes, which is often not done efficiently by researchers who are not professional model designers. Therefore, it is necessary to investigate how to recommend a set of activity nodes as candidates for the next activity node in the current art exhibition activity recommendation model through interaction with the user, in order to effectively assist the user to complete the modelling.

In terms of recommendation method research, a recommendation framework that can improve the efficiency of workflow model design was proposed and a prototype system was constructed in the literature [10]. The system can select models from the model library that match the model currently under construction in terms of syntax and semantics according to the model currently being constructed by the user and recommend them to the user for reference. A recommendation method called FlowRecommender has been proposed in the literature [11]. This method first mines the patterns between the active node and its upstream subpaths and then recommends the node that best matches the requirements based on the structural similarity between the current patterns. However, the method does not consider the scientific workflow modelling needs of the people involved, nor does it consider factors such as the semantic similarity between current modelling needs and historical workflow segments as a basis for recommendations. The literature [12] considers the social network and interaction information between developers and proposes a connection-aware rule-based recommendation method that can recommend the required model based on the user's requirement description text. However, the method does not consider the current modelling situation of the people involved.

To address this problem, this paper proposes an interactive modelling-oriented recommendation method for classical art exhibition activities, which can interact with researchers or model designers through an assisted modelling tool to recommend a set of candidate activity nodes that meet the current modelling needs of art exhibition activities. We use the exhibition activity fragments as the recommended reference model and recommend reasonable classical art exhibition activities based on the art exhibition model under construction and the modelling needs of the audience through operations such as data preprocessing and calculating the matching degree.

2. Relevant Definition Principles

There are three main core issues from the study of art exhibition event recommendation systems. The first is the user modelling problem, which is to build a user model according

to the user state. The second is the recommendation object modelling problem, which is to build the recommended object model according to the user parameters. The third is the recommendation algorithm design problem, integrating user resources to improve the efficiency and precision of operations. In addition, the recommendation activity is a process of user cognitive construction and is continuous and coherent; therefore, the evaluation and tracking of the recommendation effect is also an important issue that should be addressed by the recommendation system.

Sequential and parallel control structures are most common in classical art exhibition activity recommendation models in AEEMS application environments, and some AEEMS do not support modelling of conditional, selective, and cyclic control structures. Moreover, an interactive approach to assist art exhibition activity recommendation modelling can help to recommend the next available or referenced activity for those involved and improve their modelling efficiency. Therefore, this research focuses on the next art exhibition activity construction scenario, and the proposed problem can be described as follows: assuming that the person concerned is performing process modelling, given an unfinished art exhibition activity recommendation model and a search requirement for that activity, recommend suitable art exhibition activities to meet the current process modelling requirements.

In this regard, this paper proposes an art exhibition activity recommendation strategy based on art exhibition fragments, starting from the graph structure characteristics of the art exhibition activity recommendation model. The concepts and definitions related to art exhibition event fragments are introduced as follows.

(1) Art exhibition event recommendation model: an activity recommendation model can be described as $sw = < nm, sw\_dsc, sw\_D, sw\_A, sw\_L, sw\_s >$, where nm is the name of sw, sw_ds_c is the descriptive information of sw, sw_D is a set of subart exhibition activities contained in sw, sw_A is a set of activities contained in sw and each activity has a different activity name and descriptive information, sw_L is a set of edges connecting the subworkflows in sw_D to the activities in sw_A, sw_s is the starting point of sw, and $sw\_s \in sw\_DU sw\_A$.

It is worth noting that activities in the description of an art exhibition activity recommendation model are those directly included in that art exhibition activity and do not relate to activities in that art exhibition activity subcategory. Alternatively, an activity in a subcategory may be described as an art exhibition activity recommendation model.

(2) Art exhibition activity subgraph: given an art exhibition activity model sw, an art exhibition activity subgraph is a connected subgraph extracted from sw and can be described as $psw = < psw\_D, psw\_A, psw\_L, sw\_s >$ and satisfies the following conditions:

(1) $psw\_D \subseteq sw\_D$, $psw\_A \subseteq sw\_A$, $psw\_L \subseteq sw\_L$, $sw\_s \in psw\_DU psw\_A$

(2) $\forall swd_i \in psw\_D$, there is a path from sw_s to swd_i in psw.

(3) $\forall a_i \in psw\_A$, there is a path from sw_s to a_i in psw.

(3) The upstream subgraph of an art exhibition activity: given an art exhibition activity subgraph psw and an art exhibition activity a in psw, the upstream subgraph of activity a is a connected subgraph obtained by extracting activity a from psw, which can be described as $psw' = < psw\_D', psw\_A', psw\_L', sw\_s' >$, where $sw - s'$ is the start point of psw and satisfies the following conditions:

(1) $psw\_A' = psw\_A - \{a\}$, $psw\_D' = psw\_D$, $psw\_L' \subseteq psw\_L$.

(2) If sw_s' is empty, then psw_D', psw_A', psw_L' are empty.

(3) If sw_s' is not empty, then $\forall swd_i \in psw\_D'$ holds, there exists a path from sw_s' to swd_i in psw'. $\forall a_i \in psw\_A'$ holds, a path from sw_s' to a_i exists in psw'.

(4) Art exhibition activity fragment set: the set of art exhibition activity fragments can be described as $WF = \{Wf_1, Wf_2, \ldots, Wf_i, \ldots, Wf_I\}$, where $Wf_i = < a_i, psw_i' >$ is the i rd art exhibition activity fragment and satisfies psw_i' as the upstream subgraph of art exhibition activity a_i.

(5) User's recommendation requirements for art exhibition activities: in an interactive modelling environment, a user's recommendation requirement for an art exhibition event can be described as (Q, ISW), where Q is the activity query submitted by the user and ISW is a recommendation model for an art exhibition event currently under construction by the user.

(6) Semantic and structural similarity: the semantic similarity between art exhibition activity segments and users' recommendation needs for art exhibition activities is the similarity between their related text descriptions, and the structural similarity is the similarity in terms of the connection relationships between the related art exhibition activities they contain.

3. An Interactive Modelling-Oriented Approach to Recommending Classical Literature Art Exhibition Events

For the art exhibition event recommendation system, the first problem to be solved is the modelling of the user and the recommendation object. By transforming the explicit features of users and recommended objects or extracting latent features, we can complete the modelling of recommended objects, that is, to constitute their uniqueness or similarity representation. In a recommendation system, user characteristics including learning preferences, style, and background should be taken into account. The audience representation module uses algorithms to efficiently represent the personalised parameter values that are reflected in the learning process and to make them as rich as possible in terms of personalised semantics. The role of the recommendation object representation module is to extract the

features of the recommendation object and to further transform the recommendation object model. The recommendation algorithm module processes the user and recommendation object models to achieve recommendations.

Unlike other recommendation systems, the recommendation object for an art exhibition event can be a single resource or a recommendation path consisting of a combination of several related resources. This is because single resource recommendations can lead to a number of problems in a complete process. The first is to ignore the user's preferences for different resources, and recommending only one resource may discourage users who do not themselves like such resources. The second is to ignore the progress and changes that users make in the process, thus losing the guiding role of activity recommendations. As can be seen, the problem of recommending activities for classical literature and art exhibitions should also consider the impact on the effect of user liking, based on the matching of multiple resources to user characteristics.

3.1. Basic Idea. This paper presents a recommended method for classical literature and art activities (RMCLA) for interactive modelling. The basic idea is to use fragments of classical literature and art exhibition activities as the recommended reference model. To ensure that the classical literature and art exhibition activities in the reference model can match the activity query submitted by the user, the corresponding classical literature and art exhibition activities can be matched. Exhibition events will be recommended.

Specifically, the method consists of four steps: the construction of a classical art exhibition fragment set and preprocessing of clusters, the selection of a subset of similar classical art exhibition fragments, the screening of similar classical art exhibition fragments, and the recommendation of candidate classical art exhibition activities. The key point of the method is the calculation of the matching degree between the classical art exhibition segments and the user's recommendation requirements for classical art exhibition activities.

The steps of the RMCLA algorithm are shown in Figure 1. The detailed steps are as follows:

Step 1: construction and clustering of classical literature and art exhibition activities fragments: firstly, the classical literature and art exhibition activities model is obtained from the scientific workflow library, and according to the starting point of this model, algorithms such as graph mining (for example, the gSpan algorithm [13]) are used to extract the subgraphs that meet the requirements. Then, based on these subgraphs, a hierarchical traversal algorithm is used to obtain different classical art exhibition activities with their upstream subgraphs, so as to construct a set of classical art exhibition activities fragments that meet the requirements. Finally, based on the information of the upstream subgraphs in the classical art exhibition activity fragments, the fragment sets are clustered based on the classical art exhibition activity clustering method [14] to classify the classical art exhibition activity fragment sets.

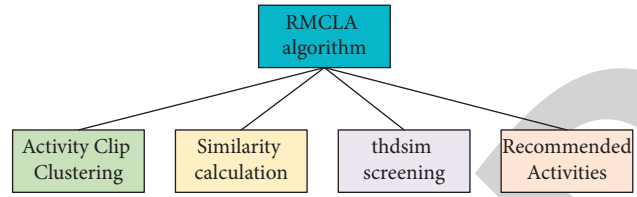

Figure 1: Basic steps of the RMCLA algorithm.

Step 2: selecting similar classical art exhibition activity fragment subsets: firstly, the subsets of fragments that have been divided are obtained based on the subset centre of gravity finding method [15–17] to obtain the centre of gravity fragments in the subsets. Then, based on the Doc2vec model [18] and the graph editing distance, the matching degree between the user's recommendation needs and the centre of gravity classical art exhibition activity fragments is calculated, and the subset of fragments with the maximum matching degree is selected. The Doc2vec model can be trained using a corpus of texts describing classical literature and art exhibition activities.

Step 3: screening similar classical art exhibition segments: according to the preset matching degree threshold thd_{sim}, the segments with higher semantic similarity and structural similarity to the user's recommendation needs are screened out in the subset of similar segments and added to the segment selection set.

Step 4: recommending the candidate classical art exhibition activities: in the candidate set of snippets, select the workflow activities in the top K snippets with high matching degree, and use them as the final classical art exhibition activity recommendation results.

3.2. Matching Degree Calculation Based on Doc2vec and Graph Editing Distance. The Doc2vec model is based on the Word2vec [19] model, which can effectively convert paragraphs or sentences into a vector representation with fixed dimensions and has been widely used in text processing related tasks. This paper adopts a method based on Doc2vec and graph edit distance. According to the steps in Algorithm 1, the matching degree between the classical literature and art exhibition activity segment and the user's recommendation demand for the activity can be calculated. This algorithm can be used directly to construct the IsMaxSimFragment and SimFragment methods in Algorithm 1.

Algorithm 1 consists of the following main steps.

4. Experimental Evaluation

4.1. Dataset. In order to establish a data set for the recommendation research of classical literature and art exhibitions, this paper sends out questionnaires to students, teachers, and people who are interested in classical literature and art exhibitions to solicit the wishes of different people. Consult experts and practitioners in the industry. The experiment was conducted according to the principle of five-fold cross-

Step 1: Training the Doc2vec model: the main process of its training can be described as follows: 1) Construct a text set of descriptions of classical literature and art exhibition activities by extracting relevant description texts of classical literature and art exhibition activities, subcategories, and activities. The text set is preprocessed with lowercase, word splitting, stemming, and deactivation to form corpus $Q = \{x_1, x_2, \ldots, x_j, \ldots, x_N\}$, where x_j denotes the j word and N is the total number of words in the corpus. The Doc2vec model is trained using the contextual data $P = \{x_{j-k}, \ldots, x_{j+k}\}$ from corpus $Q = \{x_1, x_2, \ldots, x_j, \ldots, x_N\}$ as the input layer data, and the trained word vector matrix W and paragraph vector matrix R are obtained.
Step 2: Calculate the semantic similarity between the activity query submitted by the user and the activity fragment of the classical art exhibition based on the Doc2vec model. Firstly, the activity description text of the activity query and the activity fragment of the classical art exhibition are input into the trained Doc2vec model to obtain the corresponding vector representation of these two texts. Next, the semantic similarity between the two texts is calculated using cosine similarity.
Assuming that the event query is Q and the event description text is dsc, the semantic similarity between Q and dsc can be described by equation:
$\mathrm{sim}_{\mathrm{sem}}(Q, dsc) = ((v_i \cdot v_j / \|v_i\| \cdot \|v_j\|) + 1)/2.$
where v_i and v_j denote the vector representation of Q and dsc, respectively, after input into the Doc2vec model, and the symbol $\|v_i\|$ denotes the mode of the vector.
Step 3: Calculate the semantic and structural similarity between the classical art exhibition activity fragment Wf_i and the classical art exhibition activity ISW currently under construction based on the graph editing distance. In this paper, we calculate the similarity between Wf_i and ISW based on the cost of the transformation operation, based on the similarity measure of the process model based on the graph edit distance in the literature [20]. Firstly, the cost of the node addition and deletion operation is denoted as 1, while the cost of the node replacement operation is denoted as $1 - \mathrm{sim}_{\mathrm{sem}}(n_i, n_j)$, where $\mathrm{sim}_{\mathrm{sem}}(n_i, n_j)$ denotes the semantic similarity of the two activities. Secondly when a node is added or deleted, the cost of each edge corresponding to the node to be added or deleted is recorded as 1. Finally, based on these costs, the semantic and structural similarity is calculated.
Step 4: Combine the semantic similarity and structural similarity obtained in the first two steps, and output the final match between the classical art exhibition segment and the user's recommendation for the classical art exhibition event.

Algorithm 1: Matching algorithm.

validation by first dividing the entire dataset into five randomly sized data subsets, then taking one of the subsets as the test set and the remaining four subsets as the training set each time without repetition and conducting a five-fold cross-validation process to obtain the evaluation results on different indicators on the five test sets. Finally, these evaluation results were averaged by different indicators to obtain the final evaluation results. The datasets are shown in Table 1.

As shown in Table 1, RMCLA_200 contains 200 classical art exhibitions with a total of 800 activities, and each classical art exhibition contains between 2 and 120 activities. According to this dataset, by applying the gSpan algorithm and setting the parameter minSup in this algorithm to 1, 8500 subgraphs of activities of classical art exhibitions that meet the experimental requirements can be obtained.

4.2. Experimental Evaluation Metrics. In order to evaluate the effectiveness of activity recommendations, the desired recommended activity list A_{ept}, and the actual recommended activity list Arec are constructed. Based on this, three evaluation metrics, accuracy, recall, and F_1 (F-Score), are defined and described as follows:

$$\begin{aligned} \text{precision} &= \frac{|A_{\mathrm{rec}} \cap A_{\mathrm{ept}}|}{|A_{\mathrm{rec}}|}, \\ \text{recall} &= \frac{|A_{\mathrm{rec}} \cap A_{\mathrm{ept}}|}{|A_{\mathrm{ept}}|}, \\ F_1 &= \frac{2 \times \text{precision} \times \text{recall}}{\text{precision} + \text{recall}}, \end{aligned} \tag{1}$$

Where $|A_{\mathrm{rec}}|$ and $|A_{\mathrm{ept}}|$ describe the number of activities in lists $|A_{\mathrm{rec}}|$ and $|A_{\mathrm{ept}}|$, respectively, and $|A_{\mathrm{rec}} \cap A_{\mathrm{ept}}|$ indicates the number of activities that coexist in both activity lists.

4.3. Evaluation of Recommendation Results. The results of the experiments in FlowRecommender (notated as FlowRec) were compared to the results of the experiments, and the results were evaluated and analysed in the following two ways.

Analysis of the effect of matching threshold $\mathrm{thd}_{\mathrm{sim}}$ on recommendation results: to investigate the effect of the matching threshold $\mathrm{thd}_{\mathrm{sim}}$ on the RMCLA method in terms of accuracy, recall, and F_1, the recommended number of activities K was set to 10 and $\mathrm{thd}_{\mathrm{sim}}$ assigned to the values 0.74, 0.78, ... , 0.94, respectively, 0.94. The specific data of accuracy and recall with the increase of $\mathrm{thd}_{\mathrm{sim}}$ are shown in Tables 2 and 3, and it can be seen that the RMCLA method has improved in terms of accuracy, recall, and F_1.

A comparative image of the two cases is shown in Figure 2.

There may be less activity in A_{ept} when the threshold $\mathrm{thd}_{\mathrm{sim}}$ is set to a relatively large value. As a result, a significant amount of activity in A_{rec} is not present in 4, resulting in a reduction in accuracy. In Figure 1, it can be seen that when A_{ept} is varied from 0.74 to 0.82, the accuracy of the RMCLA is relatively stable, as most of the expected fragment similarity values fall within these two ranges. When $\mathrm{thd}_{\mathrm{sim}}$ is set to 0.86 to 0.98, the number of activities in A_{ept} decreases sharply, as there are very few of these extremely similar expected activities and the RMCLA method can focus on both semantic similarity and structural similarity.

Table 1: Distribution of datasets.

Dataset name	Number	Total number of activities	Range of activity numbers
RMCLA_200	200	800	2~120

Table 2: Accuracy of classical literature and art exhibition activity recommendations under different thd_{sim}

thd_{sim}	RMCLA	FlowRec
0.74	0.94	0.78
0.78	0.92	0.76
0.82	0.90	0.70
0.86	0.84	0.58
0.94	0.38	0.25
0.98	0.29	0.18

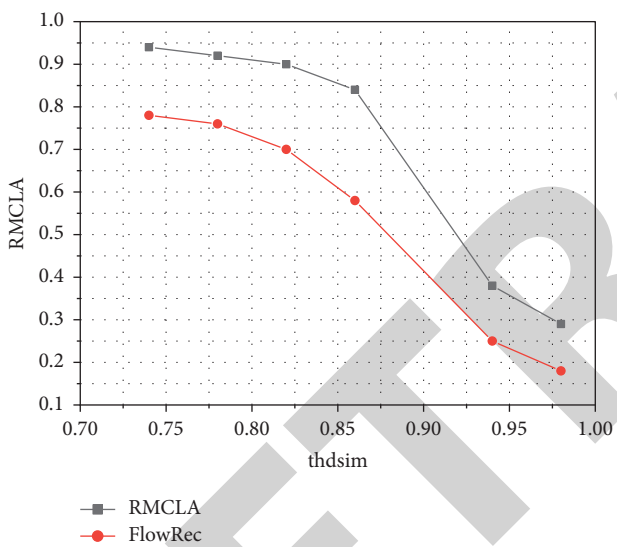

Figure 2: Comparison of the accuracy of recommendations for classical literature and art exhibition activities under different thd_{sim}.

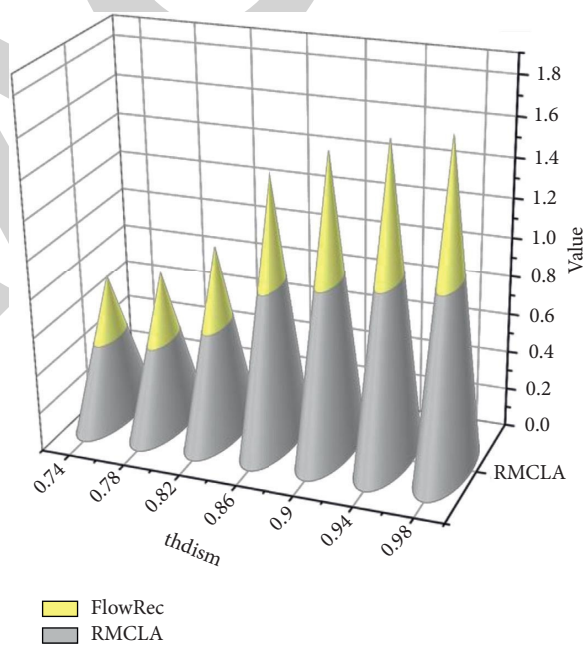

Figure 3: Comparison of recommended recall rates for classical art exhibition events under different thd_{sim}.

A comparison of the recall data for the two methods is given in Figure 3.

The data for the effect of thd_{sim} on the recommended outcome F_1 values are shown in Table 4.

A comparison of the F_1 value data for the two methods at different thd_{sim} values is shown in Figure 4.

The effect of the number of recommended activities K on the recommendation results: to investigate the effect of the number of recommended activities K on the recommendation results of the RMCLA method, thd_{sim} was set to 0.86, while K was set to 6, 10, ..., 30, respectively. As shown in Tables 5 and 6, as the value of K increases, the accuracy and recall show a decreasing and increasing trend, respectively, and the RMCLA method outperforms the FlowRec method in terms of accuracy, recall, and F_1.

Table 3: Recommended recall of activities for classical literature and art exhibitions under different thd_{sim}.

thd_{sim}	RMCLA	FlowRec
0.74	0.42	0.32
0.78	0.45	0.35
0.82	0.57	0.41
0.86	0.82	0.57
0.90	0.88	0.65
0.94	0.92	0.70
0.98	0.95	0.72

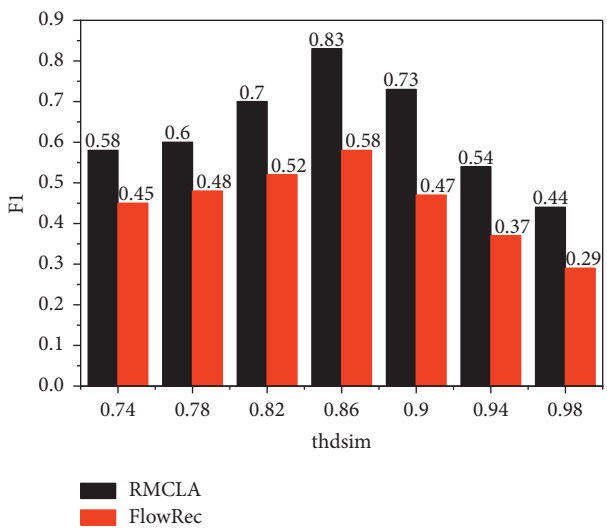

Figure 4: Comparison of F_1 value data for the two methods.

Table 4: Effect of thd_{sim} on F_1 recommended outcome values.

thd_{sim}	RMCLA	FlowRec
0.74	0.58	0.45
0.78	0.60	0.48
0.82	0.70	0.52
0.86	0.83	0.58
0.90	0.73	0.47
0.94	0.54	0.37
0.98	0.44	0.29

Table 5: Accuracy data for different K values.

K	RMCLA	FlowRec
6	0.92	0.83
10	0.86	0.61
14	0.78	0.52
17	0.58	0.41
22	0.49	0.38
26	0.47	0.32
30	0.45	0.30

A visual comparison of the accuracy of the two methods at these seven K values is shown in Figure 5.

As can be seen from Figure 5, the accuracy of both activity recommendation methods starts to decrease when K is set to a larger value, as these methods recommend too many activities that are not actually very relevant to the needs of the person concerned and therefore may not be present in the A_{ept}.

A comparison of the recall data for different K values is shown in Figure 6.

As shown in Figure 6, the recall rate for all methods gradually becomes relatively stable as K changes from 16 to 30, as most of the expected activities in the A_{ept} have largely been identified and recommended to the relevant people at this point, and data on the effect of K on the value of F_1 are given in Table 7.

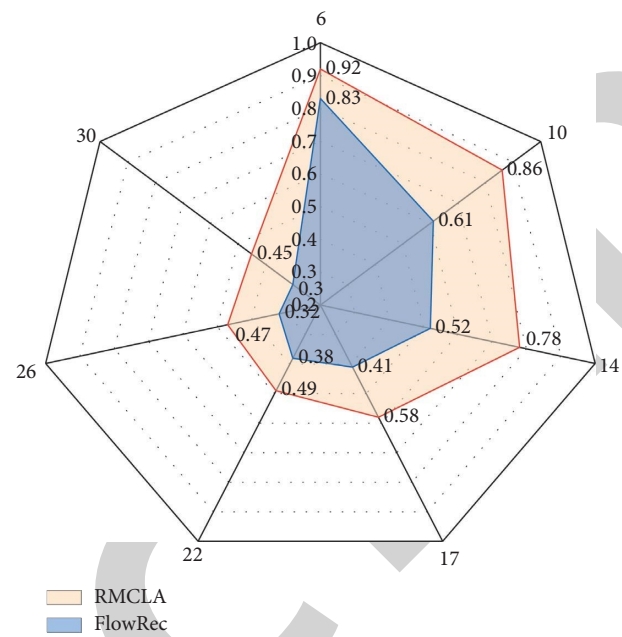

Figure 5: Comparison of the accuracy of the two methods for different values of K.

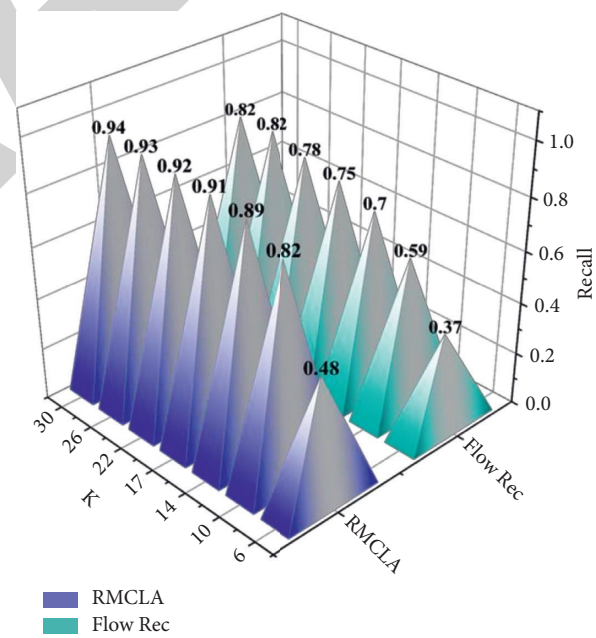

Figure 6: Comparison of recall data for different K values.

Table 6: Recall data for different values of K.

K	RMCLA	FlowRec
6	0.48	0.37
10	0.82	0.59
14	0.89	0.70
17	0.91	0.75
22	0.92	0.78
26	0.93	0.82
30	0.94	0.82

Table 7: Effect of K on the recommended outcome F_1 value.

K	RMCLA	FlowRec
6	0.63	0.51
10	0.84	0.60
14	0.83	0.60
17	0.71	0.53
22	0.64	0.51
26	0.62	0.46
30	0.61	0.44

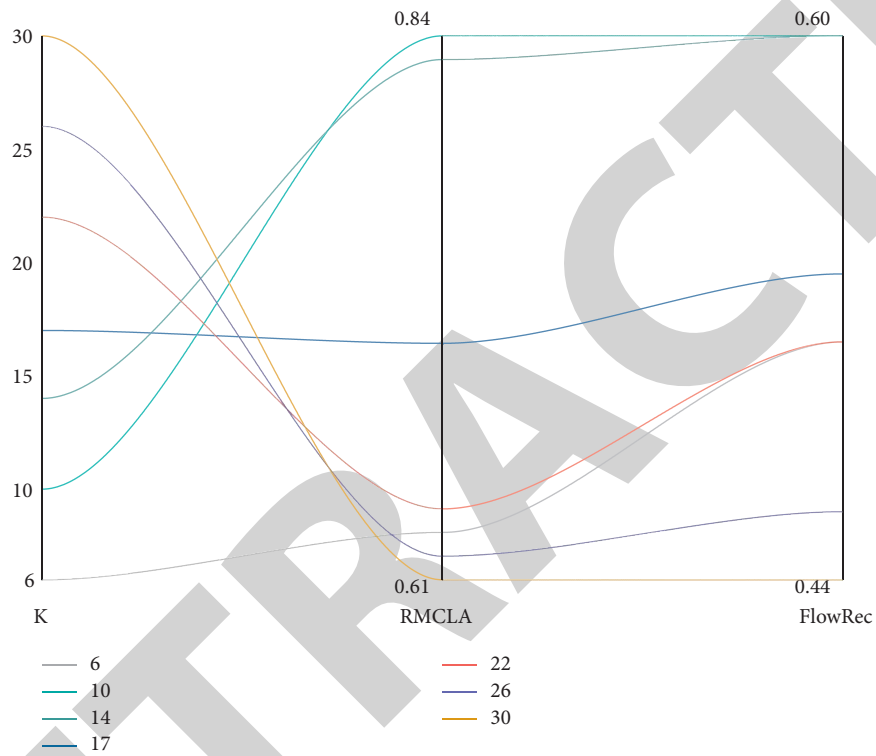

Figure 7: Comparison of the effect of the F_1 value for the same K value.

The comparative results of the two methods for F_1 values at different K values are shown in Figure 7.

As can be seen in Figure 7, the F_1 values for both methods increase when K is set to 6 to 14, while the F_1 values for all the recommended methods for the campaign tend to decrease when K is assigned to 18 or even higher.

5. Conclusion

This paper proposes an activity recommendation method for interactive modelling of classical literature and art exhibition activities and the interactive modelling needs of the audience and collects experimental data through questionnaires and interviews to verify that the proposed method outperforms the comparison method in terms of accuracy, recall, and F_1. The experimental results show that the smaller the matching degree threshold, the higher the accuracy rate of classical literature and art exhibition event recommendations, but the opposite is true for the recall rate. When the matching threshold is fixed, the higher the value of K, the lower the accuracy of the event recommendation, but the higher the recall. The optimal parameter value can be found to optimise the recommendation F_1 results through a comprehensive analysis. Since the dataset in this paper comes from limited questionnaire results, in order to make the proposed method more convincing, future research will broaden the source of the dataset. In future research, we can also consider combining factors such as the modelling theme of the classical literature and art exhibition event to further enhance the intelligence of the event's recommendation.

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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Retraction

Retracted: Optimization and Combination Analysis of English Multimodule Learning Strategies based on Computational Intelligence

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] X. Bao, "Optimization and Combination Analysis of English Multimodule Learning Strategies based on Computational Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 9630353, 9 pages, 2022.

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Research Article

Optimization and Combination Analysis of English Multimodule Learning Strategies based on Computational Intelligence

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Due to the stagnation of foreign language teaching method research and the rapid development of cognitive psychology, in the early 1970s, the research focus of foreign language teaching changed from teacher to student research. In this context, the research of English learning strategy entered the historical stage of foreign language teaching research, and the global research of foreign language learning strategy was launched. In the past 30 years, the study of English learning strategy has been a hot research topic in the field of education in China. Finally, we conclude that English learning strategy training is the result of learning strategy training. In addition, the learning strategy training also effectively improves the English learning level of the students in the experimental class. This study aims to solve the problem of optimization and combination of English learning strategies, find effective ways and implement feasible programs, and propose theoretical and practical ways in college English teaching reforms. The connotation of "multimodule" has not been given due attention, so its role has not been fully brought into play. The following questions are answered, such as "teach students complete skills," "train students in strategies," "treat the teaching process correctly," "Chinese computational intelligence has many patterns, but few practical effects" and "get rid of the strange theory that cannot be taught on the basis of computational intelligence" and "let students experience the practical process of English multimodule learning strategies and applications based on computational intelligence. The problems all seem to be related to "multimodules."

1. Introduction

In this study, a model for minimizing energy consumption and reducing room temperature is proposed, and an intelligent algorithm is applied to solve the nonparametric model, and experiments are used to compare the performance of three computational intelligence algorithms. The experimental results show that the particle swarm optimization algorithm is suitable for solving the proposed model [1]. The article introduces the ACO algorithm, all ACO algorithms have the same idea, and ACO is formalized as a meta-heuristic for combinatorial problems. It is foreseeable that future research on ACO will pay more attention to rich optimization problems including randomness [2]. In this study, we propose an incremental method for finding all maximizing generalized rules and adaptively modifying them as new data becomes available. The method was developed in the context of rough set theory and is based on the early discriminability matrix idea introduced by Skowron [3]. This study proposes a new form of mathematics for dealing with complex mathematical problems arising in cognitive computing, computational intelligence, software design, and information technology. This study describes the scope and framework of reference mathematics and explains cognitive informatics and computing intelligent applications [4]. This article discusses constructivism and its role in English as a second language learning, including its main teaching methods and perspectives, and several main teaching modes. The author hopes to reveal the guiding and inspiring role of constructivism in English learning in theory and practice [5]. Worldwide, foreign language teaching, especially EFL teaching, starts at an increasingly early age and takes up more space throughout the primary and secondary school curriculum. This study

focuses on vocabulary growth in secondary schools in the eastern German state of Saxony over eight years. This study also discusses the relationship between test scores and background data, such as learning strategies, etc [6]. Based on experiments, this study analyzes the correlation between self-concept and English learning, with particular emphasis on the comparison between self-concept and spoken English. Through the recorded oral English test, according to the evaluation of the college English test oral test, the score is given first, and the experimental results show that the self-concept corresponds to the performance in English [7]. The study, which aims to describe the grammatical mistakes students make when translating Indonesian into English, was also made up of 270 students in the sixth semester, with a sample of 30 students. The findings show that the most common errors at both levels are errors in verbs; and that most errors are due to overgeneralization and ignorance of rule constraints [8]. According to preliminary research conducted by the English Learning Program, it was found that students still have problems comprehending reading texts, their ability to comprehend reading texts is still insufficient, and students' lack of ability may be caused by several factors. First, their vocabulary is still limited; second, their motivation to learn English, especially to read texts, is still low [9]. The article presents an apparatus and method for automatically optimizing a policy in a decision management system, where the end user of the system selects a portion of the policy for optimization and selects conditions for optimizing the selected portion of the policy. The decision management system then automatically optimizes selected parts of the strategy based on the selected criteria [10]. Based on the research of today's mature algorithms, this study proposes a division and multilevel clustering algorithm based on multistrategy optimization. The core idea of this algorithm is to divide all data into groups. In this process, various strategies are used to improve the clustering effect, the test shows that the algorithm is one of the best algorithms [11]. In this study, we propose a linear approximation function of unit learning curve cost to describe the budget constraint of purchasing policy optimization in mixed integer linear programming. In addition, we solve the implementation problem and provide performance comparison results [12]. This study proposes a metric space structure on a finite memory policy profile set, reveals the geometric meaning of this metric about the network structure, and studies the optimization of mixed-valued logic dynamic control systems, which consider policies with initial conditions [13]. In this study, an optimal gear management strategy for automatic transmission vehicles based on dynamic programming is proposed to study the potential fuel savings. The test results of prototype vehicles on treadmills show that significant potential fuel savings can be achieved by optimizing gear shifting, and the proposed design methods are consistent [14]. The results of this study show that business and environmental characteristics have a significant impact on the overall performance of exporting companies and the strategic applicability of their marketing mix, which means that standardization or customization is useful and will produce comparable results [15].

2. Strategies to Optimize Learning Methods

2.1. The Concept of Reinforcement Learning. Reinforcement learning usually includes the following four elements: agent, state, action, and reward value. In reinforcement learning, the actors conduct decision-making activities by monitoring the environmental state, obtain the reward values from the environmental feedback, and optimize the strategy based on the reward values obtained. An important difference between reinforcement learning and other machine learning methods is that reinforcement learning emphasizes solving the problem of continuous optimization of decision making, that is the purpose of reinforcement learning is to maximize the cumulative advantages of agents, and affirmative learning is an algorithmic framework that corrects and optimizes practice through trial and error, whose official definition is as shown in Figure 1.

The agent monitors the environmental state at time t and provides the behavioral policy at this time; when the agent's decision affects the environment, it generates a new state and sends a feedback signal to the agent that accepts the state representing $t+1$ and returns the reward signal and continues the decision once for the next time t. This cycle is repeated until the environment indicates that the task is completed. In addition, the optimization goal of optimizing the reinforcement learning strategy has the following formula:

$$\text{maxmize} \sum_{t}^{\infty} r_t. \tag{1}$$

In summary, the goal of amplification chemistry is to address the optimal strategy to solve the sequencing problem, which focuses more on maximizing long-term benefits while one or two decisions yield fewer benefits.

2.2. The Markov Decision Process. The Markov decision process inherits the Markov property, which means that the state value at the next moment of the system is only dependent on the state of the system at any given time, independent of the previous historical state. In general, Markov's decision-making process consists of four parts:

S: A collection of all possible states in the environment, also known as spatial space

A: Agents the collection of all possible actions, also known as the operation mode

R: $S \times A \longrightarrow R$: Reward function in the environment

γ: Discount factor

$S$and A during the decision making represent sets of state and behavioral sets, respectively. Also, R is a reward value function used to calculate the reward value returned by the environment after the agent is in the state s and select the function a, and the discount factor is used to calculate the long-term gains to the broker. Starting from time t, the long-term benefits are calculated as follows:

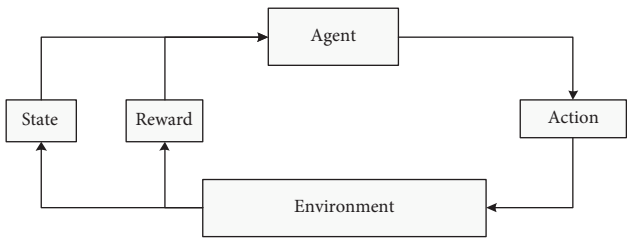

Figure 1: Framework diagram of the reinforcement learning algorithm.

$$R_t = \sum_{i=0}^{\infty} \gamma^i r_{t+i} = r_t + \gamma r_{t+1} + \gamma^2 r_{t+2} + \ldots. \quad (2)$$

An agent strategy is a probability distribution that produces different sets of reward values.

2.3. Optimal Policy Function. The state value function $V_\pi(s)$ represents the long-term reward value generated by the agent executing the policy in state s. The specific calculation formula is as follows:

$$V_\pi(s) = E_\pi\left[\sum_{i=0}^{\infty} \gamma^i r_{t+1+i} | S_t = s\right]. \quad (3)$$

The expression in the above formula expresses the expectation of the long-term benefit of using the policy under state s to solve the optimal policy, the formula is as follows:

$$\pi^* = \arg\max V_\pi(s). \quad (4)$$

The action value function $Q_\pi(s, a)$ can also be used to measure the long-term reward value generated by the agent execution policy, which is a measure corresponding to the spatial value function, defined as follows:

$$Q_\pi(s, a) = r_{t+1} + \gamma E_\pi\left[\sum_{i=0}^{\infty} \gamma^i r_{t+1+i} | S_{t=s}, A_t = a\right], \quad (5)$$

$Q_\pi(s, a)$ represents the long-term gain of the agent from agent after the state s selects and performs the function a. At this point, the optimal strategy solution formula is as follows:

$Q_\pi(s, a)$ represents the long-term benefit that agent obtains after agent chooses and performs the function a in state s. At this time, the optimal strategy solution formula is as follows:

$$\pi^* = \arg\max Q_\pi(s + a). \quad (6)$$

Regardless of whether the optimal policy is solved by the state-value function or the function is equivalent, the agent can maximize the long-term benefit in any state by implementing the optimal policy.

3. Learning Strategy Optimization Algorithm

3.1. Reinforcement Learning Algorithm. After modeling the agent-environment interaction process as the Markov decision process, according to the different strategy optimization methods, validation learning algorithm is mainly divided into two kinds: validation learning algorithm based on value function optimization and validation learning algorithm based on policy optimization, although these two methods in different ways and focus on solving problems, but the core of their optimization agent is to maximize the cumulative return of strategy and environment interaction. Depending on whether to consider the effect of the current pattern function selection on the cumulative gain, the optimization objective can still consider maximizing the state value function or the state action value function in the current state.

The state value function represents the expected value of the cumulative benefit of the agent under the current policy when the agent is in that state, which is expressed as follows:

$$V_\pi(s_t) = E_\pi[G_t | S = s_t]. \quad (7)$$

Compared with the state value function, the state action value function measures the influence of action selection, and the expected value is specifically expressed as:

$$q_\pi(s_t, a_t) = E_\pi[G_t | S = s_t, A = a_t]. \quad (8)$$

From formulas (7) and (8), the expectation of the state value function is the state action value function on the policy F distribution, which can be expressed as:

$$V_\pi(s_a) = Q_t(E_\pi(s_1 + s_2)) = \sum_a \pi * (a_t + s) q_\pi(s_t, a). \quad (9)$$

In order to use the state value function and the action state function as guidance for the policy to be updated, we need to obtain the iterative relationship of these two value functions on themselves. Therefore, by extending the expression of the state-value function, you can determine the relationship as:

$$E(s_t) = E_\pi(R_1 + \gamma R_{t+2} + \gamma^n R_n) = E_\pi\left(R_{t+1} + R_{s_t+1}\right). \quad (10)$$

Similarly, the function of the state function values can be extended to obtain the iterative formula of the function:

$$q_{s+a} = E_\pi\left(R_1 + \gamma^t q(s, a_t)\right). \quad (11)$$

According to the Bellman equation of formula (10), the Bellman optimal equation of the next state value function H and the return function J can get the value iteration formula:

$$V_{k+1}^*(s_t) = \max_a\left(R_{s_t}^a + \gamma \sum_{s_t+1} \in sP_{s_t s_t+1}^a V_k^*(s_{t+1})\right), \quad (12)$$

V_k^* and V_{k+1}^* are used to represent the current optimal state value function and the optimal state value function at the next moment after the update, respectively.

3.2. Value Iteration and Strategy Evaluation. Therefore, the main problem to be solved when using the value differential method for the strategy optimization method is the solution of the spatial value function, for which there are two main methods: the Monte Carlo method and the time series difference method. The Monte Carlo method obtains K by

sampling from the current state to the final state, using the cumulative discount as the state value function of the current state, and then making the current state value function as similar as possible. Update the policy using the sampling results as follows:

$$V_{\mathrm{k}+1}^{*}(s_t) = V_{\mathrm{k}}^{*}(s_t) + \alpha(G_t - V_{\mathrm{k}}^{*}(s_t)). \tag{13}$$

Mathematical differentiation is a linear description of the local change rate of a function. Differentiation can be used to approximately describe how the value of a function changes when the parameter value of a function changes small enough. If there is a small change H in the variable X of the function F, then the change of the function can be divided into two parts, one is the linear part, and the other is the relational part.

In contrast, the time series difference method only uses sample data with a finite number of steps to iteratively optimize the values, for example, the upgrade strategy of the TD one-step upgrade method is as follows:

$$V_{k+1}^{*}s = V_{k}^{*} + \alpha + \gamma V_{k+1}^{*}(s_t). \tag{14}$$

The first is strategy evaluation and the second is strategy optimization. In short, the strategy-based reinforcement learning algorithm directly optimizes the size of the corresponding measures in the policy distribution according to the size of the value function. The process is as follows:

$$J(\theta) = \sum_{a} \in A\pi\theta(s,a)R_{s,a}. \tag{15}$$

Equation L describes the basic goal of the reinforcement learning algorithm, and therefore, the relationship between gradient and policy can be obtained by directly deriving the cumulative benefits, which determines the direction of the policy update. The process is as follows:

$$\nabla_{\theta}\theta J(\theta) = E_{X_{\theta}}(\nabla_{\theta}\log\ \pi_{\theta}(s,a)r). \tag{16}$$

Considering the advantages of the value function optimization learning algorithm and the policy optimization learning algorithm, a framework for the actor-critical algorithm is proposed. In the verification learning algorithm based on the parameter ω value function, the key part updates the time series difference method, and the formula is as follows:

$$Q_{\omega} = \omega + \partial(R_t + \gamma q(s,a) - Q_{\theta}(s,a_t)). \tag{17}$$

The Actor part evaluates the key parts of the current policy based on the parameters and uses the policy gradient statement of the policy-based validation learning algorithm to update the parameter θ, the formula is as follows:

$$\theta = \theta + \partial\nabla\ \log\ \pi_{\theta}(s,a)Q_{\omega}(s_t,a_t). \tag{18}$$

3.3. Deep Reinforcement Learning. In principle, traditional reinforcement learning algorithms can solve most decision problems, but due to the complexity of algorithms and early computational power limitations, traditional reinforcement learning algorithms can often only solve decision problems in a simple way. DQN is an iterative value learning algorithm derived from Q-learning algorithm, but combined with the deep learning method solves the dimension explosion problem of the Q-learning algorithm. The network structure is shown in Figure 2.

Since it is impossible to calculate the expected value of the Q value corresponding to each function in the actual execution, the method adopted by DQN is to select the maximum value of the Q value corresponding to each function to be learned and converge to the optimal value. After several iterations. This process can be summarized as follows: the learned Q value is the expected maximum Q value of each function, with the following proportion:

$$E(\max(Q_1, Q_2, \ldots, Q_n)) \geq \max(E(Q_1), E(Q_2), \ldots, E(Q_n)). \tag{19}$$

3.4. Different-Strategy Reinforcement Learning. Reinforcement learning with different strategies is a general term for a class of reinforcement learning algorithms, whose equivalent is reinforcement learning with the same strategy. The classification is based on whether the policy is the same when the policy interacts with the environment and when the policy is updated. The same policy reinforcement learning algorithms require the same policies and upgrade strategies as the environment interaction, while different reinforcement policy learning algorithms are different. It does not have to be the same strategy, the specific difference is:

$$\begin{aligned} &Q(s_t,a_t) \leftarrow \partial(r + \partial q_s \cdot q_a - \gamma(s,a)), \\ &Q(s_t,a_t) \leftarrow Q_s + \partial\left(r + \gamma\max_{a_t} - q_a\right). \end{aligned} \tag{20}$$

The importance of using the absolute value of TD_error to achieve better reaction sample data. The TD_error is defined as follows:

$$\text{TD\_error} = r + \partial Q(s',a') - Q(s,a). \tag{21}$$

To enable faster policy convergence, sample data with higher absolute values of TD_error are often learned more frequently. Therefore, the PER algorithm takes the absolute value of the TD_error of each data as an indicator and samples the empirical pool data according to the value size. The sampling probability follows the following formula:

$$P(i) = \frac{P_i^a}{\sum_k P_k^a}. \tag{22}$$

The sampling weight is introduced to correct the deviation generated in the equation as follows:

$$w_i = \left(\frac{1}{N}.\frac{1}{P(i)}\right)^{\beta}. \tag{23}$$

Learning different strategies is characterized by fast convergence speed and high sample utilization rate. The introduction of an empirical replication mechanism has the advantages of reducing the correlation of sample data and improving the algorithm robustness.

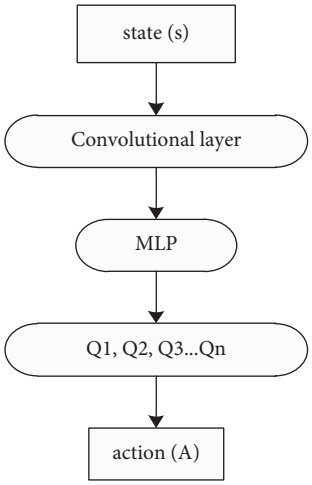

Figure 2: D Q N network structure.

4. An Empirical Study on Learning Strategy Training for English Learners

4.1. Selection of Experimental Subjects. Since we cannot disturb the normal teaching course in the learning process, we choose some "people who are not good at learning" to form the experimental class and the control class. The following two steps were performed for randomly selected classes: the first step is the single-sample *T*-test method, policy use level for each test category, and policy dominance for all subjects tested separately; the second step is the independent sample *t*-test for parameter test, the Mann–Whitney test for two independent samples, screening the policy usage status of all test categories, and determining the combinations of all test categories. There were no significant differences between the two strategies. Subsequently, the attitude of the experimental class and the control class to the strategy training was comprehensively studied. Specific statistical results are shown in Tables 1–3. The results of student comparison strategies between test and control classes are shown in Figure 3.

This can be seen from the test results in Figure 3 and Table 3. Under the condition of homogeneity of variance, the *T* value is 0.44, and the signal value (bilateral) is 0.965, much higher than the observation value of 0.05, indicating that there is no significant difference between the students in the use of English learning strategies. As can be seen from the statistical results of Tables 1–3 and Figure 3, the experimental class and control class selected in this study cannot only fully represent the parent class of this study, but also fully meet the same level. The strategies adopted and the qualitative requirements of the experimental study can ensure the authenticity and scientific nature of this study.

4.2. Content of Strategy Training. Cohen notes that "The goal of strategic education is to clearly teach students when, why, and how to use learning strategies to promote the learning and use of foreign languages." The students are encouraged to learn foreign languages on their own, rather than always relying on the teacher's guidance. The strategy training has two purposes: one is to help students with poor English to identify 50 specific strategies to use the Oxford Learning Strategy Scale; and the other is to help them. Establish a certain strategic awareness, learn to learn English, with strategic knowledge to promote their own English learning.

This strategy training takes the experimental students' strategy application level as the main reference. In terms of course content and contacts, fully considering the characteristics of researchers' strategy application, and carries out special lectures, mutual aid groups, theme activities, and strategy training activities.

4.3. Training and Analysis of English Learning Strategies. After the experiment, we made the longitudinal comparison of the experimental class students from the following seven aspects in Figure 4, and the difference significance test is shown in Table 4, aiming to determine the influence of strategy education on the level of strategy use in the experimental classroom. The proportions in Table 4 represent the 1-year English learning strategy training. The students in the experimental class showed no difference in the use of strategies such as memory, cognition, compensation, metacognition, emotion, and social interaction, and the proportion of each item is measured as a sample of a separate population, so the proportions are not correlated with each other.

The above statistics show that after a year of English learning strategy training, the students in the experimental class have no difference in the use level of memory, cognition, compensation, metacognition, emotion, social interaction, and other strategies. The overall strategy showed a clear upward trend, with statistically significant differences at 0.01, and the biggest improvement was social strategies, followed by metacognitive strategies. It can be seen that the level of the strategy application has improved after the strategy utilization rate of the experimental class after strategy training.

To test the effectiveness of strategy training in managing changes in student strategy use levels, we performed longitudinal comparisons of strategy use levels between control students before and after testing in Figure 5 and difference dominance tests in Table 5. From Figure 5 above, it can be seen that the difference before and after the experiment is not more than 0.1, and there is basically no change. Although the use of cognitive, emotional, and social strategies has improved, the improvement of cognitive and social strategies is not significant.

The statistical results in Table 5 showed that the use of six-dimensional and general strategies before and after the experiment were covered by "universal use," and the levels of memory, compensation, and metacognitive strategies used by the control group were 0.07828, 0.09848, and 0.06566 before and after the experiment, respectively. It can be seen that the difference before and after the experiment is not greater than 0.1, meaning that there is no change in principle. Furthermore, while cognitive, emotional, and social strategy use improved, cognitive and social strategies were

Table 1: Homogeneity test of the level of English learning strategies used in the experimental classes.

	Single sample T test			
Test value = 2.66	t	df	Sig (bilateral)	Mean difference
Policy average	−0.298	44	0.767	−0.01556

Table 2: Homogeneity test of the use level of English learning strategies in the control class.

	Single sample T test			
Test value = 2.66	t	df	Sig.(bilateral)	Mean difference
Policy average	−0.307	43	0.760	−0.019

Table 3: Test of significance in the level of strategy use between experimental and control classes.

	The Levene's test for the variance equation		A t-test for the mean equation			
	F	Sig	T	df	Mean variance	Standard error value
Variance is equal	0.154	0.696	0.44	87	0.00354	0.08093
Variance is unequal	0.155	0.567	0.44	84.11	0.00354	0.08108

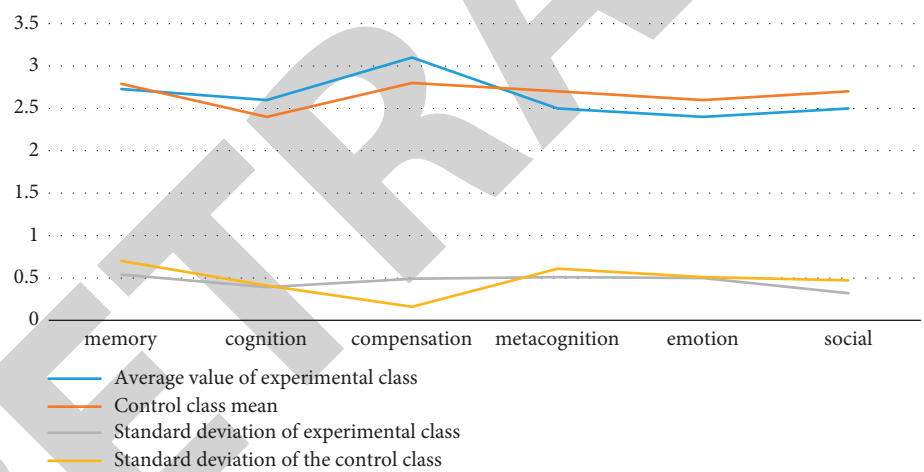

Figure 3: Comparison of student strategy usage performance between the two classes.

not significant and the change was not statistically significant, but there was a 0.31 percentage point difference in emotional strategy use before and after the experiment, which reached a statistically significant difference.

After the strategy practice, students in the test and control classes were compared laterally as shown in Figure 6 and an explicit difference test according to Table 6 to assess whether student utilization in the test class should be higher than students.

Statistics inTable 6 show that after the exam, the experimental grade students not only in memory strategy and overall strategy is better than the reference class, and all the differences reached the statistical level, the biggest difference is social strategy, on average of 1.01 points, followed by cognitive strategy and metacognitive strategy, differ more than 0.80 points. Furthermore, although affective and memory strategies were minimal, the difference was also greater than 0.50 points.

4.4. Strategy Training Results. First, from the macroscopic perspective of the strategy use level, the horizontal

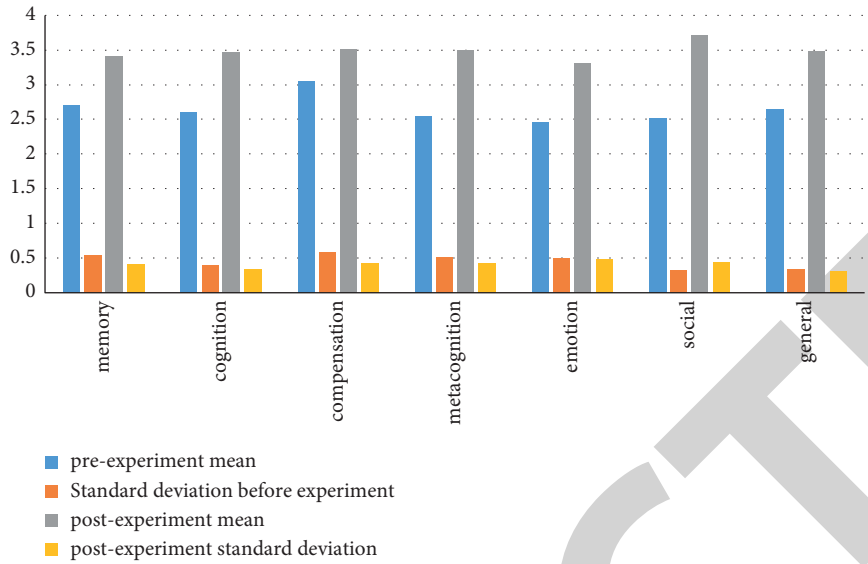

Figure 4: Comparison of the use effect of student learning strategies in the experimental class before and after the experiment.

Table 4: Results of the significance test for the differences in the experimental class.

	T price	Sig.(bilateral)
Memory strategy	−6.712	0.000
Cognitive strategy	−11.017	0.000
Compensation strategy	−4.182	0.000
Metacognitive strategy	−9.612	0.000
Emotional strategy	−8.152	0.000
Social strategy	−14.795	0.000
Total strategy	−11.971	0.000

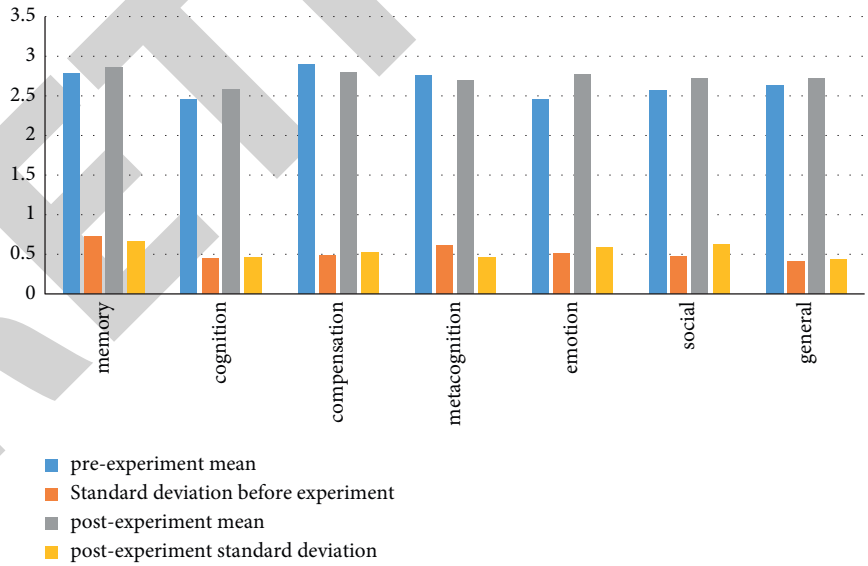

Figure 5: Comparison of the effects of learning strategies in the control class students before and after the experiment.

comparison difference of the experimental grade strategy use level before and after the experiment was 0.84 and 0.76 points, respectively. The level of strategy use of experimental and control students can prove that strategy training does improve the level of strategy use of learners, and the impact is very significant. The use of these four strategies has changed from a general level to a common postexperimental level, where English learning strategy training effectively improves the use of strategies by poor learners.

Table 5: Results of the significance test for the difference in the control class.

	T price	Sig (bilateral)
Memory strategy	−5.38	0.592
Cognitive strategy	−1.33	0.187
Compensation strategy	0.905	0.368
Metacognitive strategy	0.566	0.573
Emotional strategy	−2.638	0.010
Social strategy	−1.176	0.243
Total strategy	−0.870	0.387

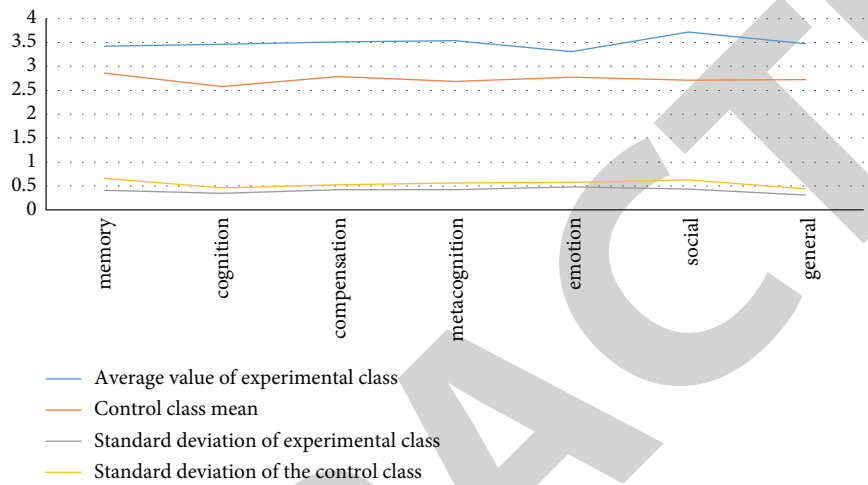

Figure 6: Comparison of the use effect of student learning strategies in the two classes after the experiment.

Table 6: Results of the significance test for the difference between the experimental class and the control class after the experiment.

	Experimental class-control class	*T* price	Sig (bilateral)
Memory strategy	0.5561	4.736	0.000
Cognitive strategy	0.8758	10.15	0.000
Compensation strategy	0.7194	7.16	0.000
Metacognitive strategy	0.8017	8.495	0.000
Emotional strategy	0.5412	4.747	0.000
Social strategy	1.138	8.799	0.000
Total strategy	0.7627	9.428	0.000

Finally, from the microperspective of the change of the use strategy level of students in the experimental class, the utilization rate of 50 strategies in the student experimental class showed that 42 out of 50 strategies showed more than 0.50, that is, 84% of the total strategies, and can reach the normal level. At the operational level, there are as many as 25 strategic products, accounting for 50% of the total strategy. The above data fully show that in the whole system of this strategy training, the experimental activities of strategy training have produced a synergistic effect, which has greatly promoted the application of other strategies among disciplines, and they have a strong sense of strategy, which has proved the success and success of this strategy training.

5. Conclusion

At present, the research on multimodal English learning strategy based on computational intelligence is finally completed, we first use the Oxford language learning strategy questionnaire as the main research tool, examined the strategy use status of 464 poor English students, widely revealed the characteristics of poor English students strategy use, and discussed the influence on their strategy formation. The level of strategy use itself, faculty, and external factors demonstrate the need and feasibility of implementing strategy training for researchers with completely poor English. It finds the factual basis for the selection of this strategic training content. Next, the results suggest that while the proportion of poorer college English researchers using the strategy is moderate, they use a wide range of strategies and have no clear preference for using it. The English learning strategy training not only improves the use level of the subject strategy but also improves greatly. In addition, the learning strategy training also effectively improves the English learning level of the students in the experimental class. First of all, the content of the survey and interview is

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Retraction

Retracted: Evaluation Method of Enterprise Management Effectiveness Based on Improved Analytic Hierarchy Process

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] L. Cheng, "Evaluation Method of Enterprise Management Effectiveness Based on Improved Analytic Hierarchy Process," *Security and Communication Networks*, vol. 2022, Article ID 2409614, 12 pages, 2022.

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Research Article

Evaluation Method of Enterprise Management Effectiveness Based on Improved Analytic Hierarchy Process

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To describe the effectiveness of enterprise management through quantitative methods, this paper established an evaluation index system through five levels: profitability, solvency, operation ability, development ability, marketization ability. The data of enterprise performance evaluation indicators were dimensionless processed to remove the influence of dimensionality of evaluation indicators and finally synthesized into a relative quantitative value. The study used hierarchical analysis on determining indicator weights. Through the construction of management possible set and management front surface, the general form of management effectiveness was put forward. By using this method, the influence of the difference of objective basic conditions between the evaluation units can be completely eliminated. There were several enterprises selected as samples to conduct an empirical study, and the results showed that the evaluation method of enterprise management effectiveness can completely eliminate the impact of differences in objective basic conditions between enterprises on the evaluation of management effect. This study shows that the evaluation method of management effectiveness can fairly describe the pros and cons of the degree of enterprise management.

1. Introduction

The evaluation of enterprise management is the premise of improving the level of enterprise management. The establishment of an accurate and effective evaluation method for the effectiveness of enterprise management can promote the analysis of gaps between enterprises [1], find the reasons for low operating efficiency, fully improve the enthusiasm of employees' enthusiasm, and extremely improve the of enterprise management's efficiency and management level goals [2].

The current literature research on enterprise management evaluation is inconsistent with their actual development, and its limitations are reflected in two aspects. One is that the evaluation methods and indicators are traditional and single, and the other is that there are differences between the evaluation units. Due to the impact of differences in objective basic conditions, it is difficult for the evaluation results to truly reflect the management efficiency of the enterprise [3]. Therefore, if such an evaluation method is used as the basis for incentives, in view of the differences in the objective basic conditions between enterprises, the evaluation results are often unfair. At the same time, this evaluation method will make the management of enterprises find the reasons from the objective conditions, resulting in insufficient analysis of their own subjective efforts, making it difficult to expect the effect of incentives.

However, the insufficiency of the above evaluation methods happens to be filled by the theory of management effectiveness. The evaluation of enterprise management effectiveness is to evaluate whether the efficiency of enterprise management, capital flow efficiency and operation efficiency of enterprise high-level structure can play an effective role. Management effectiveness eliminates differences in objective underlying conditions between assessment units in the analysis. Therefore, this method can truly evaluate the production performance of the evaluation unit due to subjective efforts. With the help of the idea of management effectiveness, by constructing an accurate and effective evaluation method to analyze and evaluate the effectiveness

of enterprise management, the management efficiency of the enterprise can be obtained. This method helps to analyze the gap between enterprises, find the reasons for the inefficiency of enterprises, fully improve the enthusiasm of employees, and approach the target of improving the management level of enterprises [4].

2. Literature Review

2.1. Analytic Hierarchy Process (AHP). Analytic hierarchy process (AHP) belongs to a branch of systems engineering. It was proposed by Darko et al. in the 1980s [5]. The AHP method is an effective way to deal with people's subjective judgments and combine quantitative and qualitative methods [6]. AHP is not only suitable for situations where there is uncertainty and subjective information, but also allows experience, insight, and intuition to be applied in a logical manner, enabling the evaluator to seriously consider and measure the relative importance of indicators. This paper uses AHP to determine the weight of enterprise management efficiency evaluation index system, which makes the evaluation system more scientific and reasonable.

AHP consists of four steps [7, 8]: the first is to establish a hierarchical structure model; the second is to construct a pairwise comparison judgment matrix; the third is to determine the relative weight of each element by the judgment matrix; the fourth is to sort the weights.

2.1.1. Establishing a Hierarchical Structure Model. The AHP decomposes different factors into multiple levels from top to bottom according to different attributes. The AHP is to decompose the decision-making problem into different hierarchies according to the order of general objective, sub-objective of each level, evaluation criterion, and even specific alternative scheme, the elements in the lower level have an impact on the upper elements and dominate the next level at the same time. The top layer is called the target layer, which generally contains only one factor. There can be one or more layers in the middle, which become the criterion layer or index layer, and the bottom layer is called the scheme layer. The criteria layer can continue to be divided into multiple levels.

2.1.2. Constructing a Pairwise Comparison Judgment Matrix. The judgment matrix is generally written in the form of formula (1), which represents the result of pairwise comparison of the importance of various factors at the same level:

$$A = \left(a_{ij}\right)_{n\times n}, \tag{1}$$

where A is the judgment matrix; n is the number of factors to be compared in pairs; a_{ij} is the ratio of factor $U_i to\ U_j$ relative to the importance of a criterion, and the importance can be assigned on a scale of 1–9 [9] as shown in Table 1. In addition, this formula also needs to satisfy the conditions of $a_{ij} = 1/a_{ji},\ i \neq j;\ i,j = 1,2,3,\ \ldots,\ n; a_{ij} \geq 0; a_{ii} = 1$.

2.1.3. Determining the Relative Weight of Each Element by the Judgment Matrix

(1) Calculate the eigenvector W of the judgment matrix, and then the normalized eigenvector is the relative weight vector.

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}},\ (i, j = 1, 2, \ldots, n),$$
$$W_i = \frac{1}{n}\sum_{j=1}^{n} b_{ij}. \tag{2}$$

a_{ij} is the ratio of factors relative to the importance of a criterion, b_{ij} is the weight of one factor among all the factors, n indicates the number of evaluation factors in the AHP, and W_i is the eigenvector of the judgment matrix.

(2) *Consistency Test.* The consistency check index CI is defined as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1},$$
$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i}, \tag{3}$$

$(AW)_i$ is the i-th component of AW, $W = (w_1, w_2, \ldots, w_n)$; $\lambda_{\max}$ is the largest eigenroot of the judgment matrix; N is the order of the judgment matrix; and W_i is the eigenvector of the factor i, that is, relative weight. The randomness index RI can be obtained from Table 2 [10].

$$\mathrm{CR} = \frac{\mathrm{CI}}{\mathrm{RI}}. \tag{4}$$

When the order is less than or equal to 2, the matrix is always completely consistent and when the order is greater than 2 and$CR < 0.1$, it can be considered that the consistency of the judgment matrix meets the requirements.

2.1.4. Performing Weight Total Sorting. Calculating the composite weight of each layer of factors to the system goal, and at the same time, the effect (relative weight) of each factor or criterion on the realization of the system goal can be sorted.

2.2. Basic Theoretical Analysis of Management Effectiveness

2.2.1. The Connotation of Management Effectiveness. The theory of management effectiveness is derived from the theory of business management [11]. Enterprise management refers to the behavior of enterprise owners or business operators to plan, make decisions, organize, lead, and coordinate all economic activities of the enterprise in order to achieve the business goal of maximizing profits [12].

Table 1: The scale of absolute numbers.

Importance intensity	Definition	Explanation
1	Equal	Two activities have equal contribution to the objective
2	Weak/slight	
3	Moderate	One activity is faintly preferred over another, established on judgment and experience
4	Moderate + plus	
5	Strong	One activity is strongly preferred over another, established on judgment, experience
6	Strong + plus	
7	Very strong (proved importance)	One activity is very strongly preferred over another, established on judgment, experience; its dominance is proved by practice
8	Very–very strong	
9	Extreme	The substantiation when one activity is preferred over another is at the topmost possible order of affirmation
Reciprocals of abovementioned	If activity i is attributed one of the abovementioned non–zero values when compared to activity j, then activity j when compared to activity i has the reciprocal value	A reasonable statement

Table 2: The value of the random consistency indicator (RI).

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

2.2.2. General Forms of Management Effectiveness. Management effectiveness evaluation reflects the management level of the evaluation unit, and this evaluation method takes dynamic performance changes as the basic premise [13]. Therefore, a method to reflect the effective effort level of each evaluation unit can be proposed first by describing the performance of the evaluation unit. Discovering and finding the frontiers of the effort level of the assessment unit is the basic premise of evaluating the assessment unit. This frontier is generally referred to as the "management frontier," which can be interpreted as the optimal management level among the levels (or possible sets of management) that all management activities can be achieved [14].

There are assessment units, the performance value of the assessment unit in period $t-1$ is A, and the performance value of the assessment unit in period t is B. Hence, both A and B show the performance level of the assessment unit in these two periods. Here, we define A and B as the reference index and the current index, the former showing the objective underlying conditions of the assessment unit. (A, B) are the index status of the assessment unit, reflecting the status of the management activities of the assessment unit [15, 16].

Definition 1. The set of management possibilities V represents the set of all possible management activities: $V = \{(A, B)\}$. A possible management set is located in the first quadrant area of the coordinate axis and is formed by the combination of the reference index and the current index. The positive direction of the X-axis is the reference index axis; the upper bound of this area is a curve: $B = f(A)$, which is the A curve changes as the industry changes. The management possible set V must meet the following requirements:

F1: $(A,0) \in V$, that is, no matter what the reference index changes, the current index may be zero; $(0,B_0) \in A$ when $B > B_0$, $(0,B_0) \in V$, that is, the starting point of the curve is a certain point on the current index B, that is to say, when the reference index of period $t-1$ is zero, the current index of period t cannot be infinite.

F2: For any given A, V has an upper bound, that is, when the reference index of period $t-1$ is determined, the current index of period t cannot be infinite. This is the bound of managing the possible set.

F3: $(A,B) \in V \Rightarrow (\lambda A,B) \in V$, where $\lambda \geq 1$, that is, for any given current index of period t, it can be obtained under the reference index of period $t-1$. This is the ineffectiveness of managing possible sets.

F4: $(A,B) \in V \Rightarrow (A,\lambda B) \in V$ where $0 \leq \lambda \leq 1$, that is, for any given reference index in period $t-1$, there may be a lower current index; this is also Manage the invalidity of possible sets.

F5: $(A_1,B_1) \in V$, $(A_2,B_2) \in V \Rightarrow (\lambda A_1 + (1-\lambda)B_2, \lambda B_1 + (1-\lambda)B_2) \in V$, where $0 \leq \lambda \leq 1$ means that V is Convex set. This is the convexity that governs possible sets.

F6: V is the smallest set that meets the above conditions. This is the minimum that manages the possible set.

Definition 2. If the management index status of an evaluation unit is (A,B) and it is on the upper bound curve of the management possible set V, then this unit is effectively effective. If the management index status (A,B) is in the internal area of the management possible set V, then this unit is invalid.

The evaluation unit (A_1,B_1) is effectively managed. Compared with other evaluation units, such as the evaluation unit (A_2,B_2), under the same reference index, the current index of the evaluation unit (A_1,B_1) is the highest. Therefore, the evaluation unit (A_1,B_1) belongs to the management and is effective. Compared with the evaluation unit

(A_1,B_1), the management levels of the evaluation units (A_2,B_2) and (A_3, B_3) are in an invalid state. When the reference index is fixed, the target current index of the evaluation unit (A_2, B_2) is the current index of the evaluation unit (A_1,B_1). Therefore, the difference between the current management indices of these two units, that is, the ratio of the current indices of the two, can reflect the effective effort of the evaluation unit (A_2, B_2). This ratio is between 0 and 1. The closer the current index is to 1, the better the management effectiveness of this evaluation unit, and vice versa. Obviously, the management effectiveness value of the assessment unit (A_1, B_1) is 1, while the management effectiveness value of the assessment unit (A_2, B_2) is less than 1.

Definition 3. The management frontier represents the upper bound curve of the management possible set, that is, the curve of $B = f(A)$. It represents the entire set of the maximum current index that the evaluation unit can achieve under any given reference index.

The management frontier enables the measurement of management effectiveness. For example, the reference index of the assessment unit (A_3, B_3) is A_3, and the other maximum possible current index is $B = f(A_3)$. By definition, the management effectiveness of the assessment unit (A_3, B_3) is $B_3/f(A_3)$.

Definition 4. The management effectiveness ME (Managerial Effectiveness) of the evaluation unit (A, B) represents the ratio of the actual current index of the evaluation unit to the projected value of the management frontier under the same reference index, that is, $ME = B/f(A)$.

The size of ME shows the effective effort of the evaluation unit to change the value of time and objectively measures the effective degree of the management of the evaluation unit. The evaluation method of management effectiveness regards the evaluation unit as a complete individual. Under the influence of the difference in objective basic conditions, the dynamic change of the performance of the evaluation unit shows the effective effort level of people. This is a fair and reasonable way to evaluate the subjective effort level of the assessment unit. According to the basic idea of management effectiveness evaluation, construct the possible set of enterprise management and get the management frontier, and then construct the enterprise management effectiveness evaluation model.

3. Method

3.1. The Construction of the Evaluation Index System of Enterprise Management Effectiveness. The construction of the performance evaluation index system is based on the principles of scientificity, comprehensiveness, comparability, measurability, and operability. In this paper, through expert interviews and literature research, and by integrating the characteristics and actual situation of current enterprises, five aspects of enterprise management are used as indicators for enterprise performance evaluation, namely, profitability (B1), solvency (B2), operation (B3), development (B4), and marketability (B5) [17], forming a hierarchical structure model, as shown in Figure 1.

The work proposes a comprehensive evaluation method of enterprise management effectiveness which integrates nonlinear fuzzy dimensionless processing method and AHP.

3.2. Dimensionless Treatment of Performance Evaluation Indicators. Dimensionless processing is a method that uses certain mathematical formulas and other methods to convert to remove the dimensional influence of evaluation indicators. This paper used nonlinear fuzzy dimensionless processing model to conduct dimensionless processing for enterprise performance evaluation index. Dimensionless was used to deal with each evaluation index, and AHP was used to get the weight coefficient of criterion layer and index layer.

The nonlinear fuzzy dimensionless processing model represents the superposition of two functions, the exponential function and the fuzzy membership function [18]. It should be pointed out that the fuzzy membership function is the independent variable of the exponential function [19]. According to the characteristics of evaluation indicators and different expressions, they can be mainly divided into three types, and the models are as follows [20]:

(1) Positive indicator model: It represents that the larger the value, the better the performance of the index, such as the rate of return on net assets and so on. The demand is greater on the basis of a larger number, and the effort required is increasing. Therefore, the quantitative value of the positive index will increase with the increase of the index value. Its model is

$$F(X_i) = \begin{cases} \dfrac{X_i - X_{i0},}{Ae^{X_{\max} - X_{i0}}} & X_i > X_{\min}, \\ 0, & X_i \le X_{\min}, \end{cases} \tag{5}$$

$X_{\max}$ is the maximum value of the i-th indicator value, $X_{\min}$ is the minimum value of the i-th indicator value, and X_{i0} is the average value of the i-th indicator value.

(2) The reverse index model represents that the smaller the index value is, the better the performance of the index is. On the basis of the smaller value, the requirement is smaller, and the required effort is increasing. Therefore, the quantitative value of the reverse index will increase as the indicator value decreases. Its model is

$$F(X_i) = \begin{cases} \dfrac{X_{\max} - X_i}{Ae^{X_{\max} - X_{\min}}}, & X_i > X_{\max}, \\ 0, & X_i \ge X_{\max}. \end{cases} \tag{6}$$

(3) Moderate index model: it represents that the index value should be moderate. When the index value is less than the moderate value, it is attributed to the nature of the positive index; when the index value is

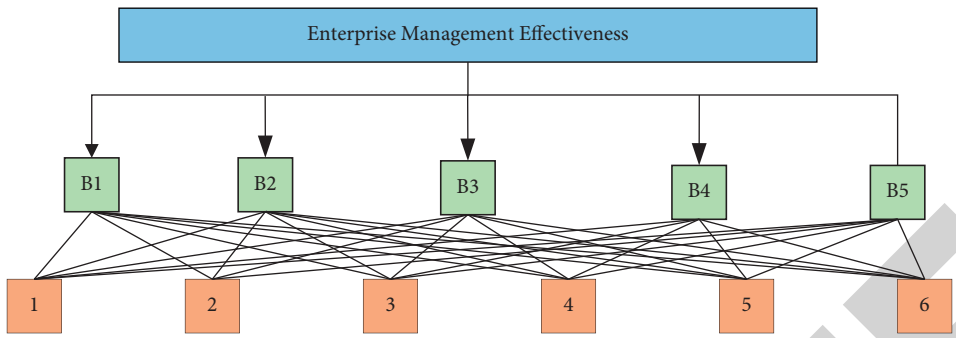

Figure 1: Decomposition of the decision-making problem into a hierarchy.

greater than the moderate value, it is attributed to the nature of the reverse index.

Appropriate indicators include the current ratio and the production–liability ratio in the enterprise management evaluation indicator system. Its model is:

$$F(X_i) = \begin{cases} \dfrac{2(X_i - X_{\min})}{Ae^{X_{\max} - X_{\min}}}, & X_{\min} < X_i < X_{i0}, \\ \dfrac{2(X_{\max} - X_i)}{Ae^{X_{\max} - X_{\min}}}, & X_{i0} < X_i < X_{\max}, \\ 0, & X_i \le X_{\min} \text{or} X_i \ge X_{\max}, \end{cases} \tag{7}$$

X_{i0} is the optimal value of the i-th index. Here, we use the traditional percentage system for calculation, and the quantitative value of the indicator is in the [0, 100] interval. The 100-point system divides the score into 100 intervals, which has a high degree of differentiation in evaluation, and the corresponding position of the score of each case can be found on the interval. The 100-point system has hundreds of grade differentials that accurately describe the level of the subject being assessed, reflecting nuances. Percentage system is also easy to statistical analysis, variable analysis judgment. At the same time, it is stipulated that when $F(X_i) = 100$, it means that the index i is in the optimal state. When the indicator is in its worst state, $F(X_i) = 0$. Therefore, for a positive indicator, if and only if $X_i = X_{\max}$, $F(X_i) = 100$; and when $X_i \le X_{\min}$, $F(X_i) = 0$. For a contrarian indicator, it is the opposite of a positive indicator. For moderate indicators, $F(X_i) = 100$ only when $X_i = X_{i0}$.

3.3. Determination of Index Weights Based on AHP

Step 1. Determine the analysis problem and build a hierarchical analysis diagram. Determining the analysis problem is the basis of AHP. Therefore, when analyzing complex problems, on the one hand, the goal of the research problem should be clear, and on the other hand, the scope of the analysis problem should be clear. On this basis, a hierarchical structure analysis diagram is constructed.

Step 2. Establish a judgment matrix. It assigns the degree of correlation to the relevant elements of each level in the hierarchical structure analysis diagram, quantifies the qualitative problems, and shows the proportion of each element in the next level to an element in the previous level. Calculate the relative weight (or called weight vector) w of each indicator in the next layer to the indicator in the previous layer. Only when the judgment matrix is not a consistent matrix, its maximum eigenroot λmax and the corresponding normalized eigenvector are the weight vector w, that is, it satisfies

$$AW = \lambda_{\max} W. \tag{8}$$

The normalized w is the sorting weight for the importance of the corresponding elements in the same layer relative to an element in the previous layer. It should be pointed out that in actual operation, the consistency of the judgment matrix needs to be checked, and the judgment matrix that cannot pass the consistency check is logically unreasonable. Only passing the weight of the test can continue to analyze the results.

$$CI = \frac{(\lambda_{\max} - n)}{(n-1)}, \qquad CR = \frac{CI}{RI}. \tag{9}$$

Step 3. Perform a hierarchical total sorting. Through the total ranking of the hierarchy, the weight of each indicator at the bottom level of the hierarchical structure analysis diagram in the overall goal can be obtained. The total ranking of layers is to calculate the ranking weight of the relative importance of all indicators at the same layer to the target layer. This process needs to synthesize the weights of each level from top to bottom. Assuming that the order of n elements ($B_1, B_2, \ldots, B_n$) in level B to the total target A is b_1, $b_2, \ldots$, bn; the single-level order of m elements in level C to the element B_j in the previous level B is $c_{1j}, c_{2j}, \ldots, c_{mj} (j = 1,2, \ldots, n)$. Then the total sorting weight of the i-th element in the C level to the total target is $w_i = b_j c_{ij}$. The obtained single-level weight results are sorted and the combined weight is calculated, and finally the total weight of each indicator can be calculated. In enterprise management effectiveness measurement method, after standardizing the data of the indicators and determining the weights, the management effectiveness score of the j-th enterprise can be obtained.

The formula is as follows:

$$P_j = \sum_{i=1}^{m} w_i F\left(X_{ij}\right), \tag{10}$$

W_i is the weight of the i-th indicator, X_{ij} is the value of the i-th evaluation index of the j-th enterprise, and $F(X_{ij})$ is the normalized value of the i-th index of the j-th listed logistics company. P_j denotes the business performance score of the jth company, and the higher the calculated evaluation score P_j, the better the business performance of the company is shown.

And $F(X_{ij})$ is the normalized value of the i-th indicator of j companies. Therefore, the higher the calculated evaluation score P_j, the better the management of the enterprise. Therefore, according to the above theory, we can easily measure the management effectiveness of the enterprise during this period through the collection of data and the evaluation method of enterprise management.

3.4. Setting of Relevant Parameters of Management Effectiveness Evaluation Model. The relevant parameters of the enterprise management effective evaluation model are mainly composed of three components: the reference index, the current index and the management possible set [21]. The evaluation of enterprise management effectiveness is a dynamic process. We generally divide the evaluation time interval into two time periods: $t-1$ period and t period. We refer to the enterprise as the price measurement unit. Let A_j be the reference index of the j-th price measurement unit (or the business performance level in the $t-1$ period), and B_j be the current index of the price measurement unit (or the business performance level in the t period), (A_j, B_j) is called The index status of the j-th price measurement unit. According to the index status of the evaluation unit, the management of the evaluation unit can be simply compared. There are two price measurement units (A_1, B_1) and (A_2, B_2). If the reference index of the former is lower than the reference index of the latter and the current index of the former is greater than the current index of the latter, it is indicated by letters as when $A_1 \le A_2 and\ B_1 > B_2$, it is obvious that the management level of the former is obviously better than that of the latter. If the former's reference index is higher than the latter's reference index and the former's current index is lower than the latter's current thinking index, the letter is when $A_1 \ge A_2$ and $B_1 < B_2$, then the management level of the former is worse than that of the latter. Assuming that the relationship between the two evaluation units (A_1, B_1) and (A_2, B_2) is not as described above, then when $A_1 \le A_2$, $B_1 \le B_2$ and $A_1 \ge B_2$, $B_1 \ge B_2$ occur, the There is no way to directly analyze which assessment unit management level is more effective.

Although it is possible to evaluate the management quality of the two evaluation units through a comparative approach. However, how to quantitatively analyze the effectiveness of management is still unresolved. Therefore, on the basis of the above problems, we should further study and discuss the management effectiveness of the evaluation unit with the theoretical support of management possibility sets and management frontiers. Taking the abscissa X as the reference index and the ordinate Y as the current index, the index status of all price measurement units can be displayed in a plane coordinate system, as shown in Figure 2. Taking the reference index and the current index as an input and an output, respectively, the frontier of the possible set of index states can be obtained by using the DEA method. Assume that the projection value of the current index B of the evaluation unit in the t-th period on the management frontier is B^*, then the ratio of B and B^* can measure the effective effort of the evaluation unit. The shaded area in Figure 2 represents the possibility of management set, and its upper boundary represents the management front. Let η be the management effectiveness of the evaluation unit, then we have

$$\eta = \frac{B}{B*} \times 100\%. \tag{11}$$

The value of η reflects the effective effort of the evaluation unit (A,B) management. Obviously, the management effectiveness excludes the influence of objective conditions on the evaluation results, and at the same time, it also shows that the difference in management of the evaluation unit produces corresponding benefits. Suppose (A_1, B_1) and (A_2, B_2) are two evaluation units, and the management effectiveness of these two evaluation units are η_1 and η_2, respectively. If $\eta_1 \ge \eta_2$, then the evaluation unit (A_1, B_1) is more (A_2, B_2) is better managed and vice versa.

3.5. Management Effectiveness Measurement Method. According to the above theories, we found that the basic condition for quantitatively describing the effectiveness of management is the establishment of the management frontier [22]. Next, we will introduce a method to measure the management frontier according to the index status of several evaluation units. The measurement and estimation of it is called the forefront of experience management. Assume that the evaluation data of the index state of a certain evaluation unit is (A_j, B_j), $j = 1,2, \ldots, n$. According to the related idea of convex sets, let $S = \{A_1, A_2, \ldots, A_n\}$ be any set in E. Also, V is a convex combination of S sets, which can be expressed as: $A \in V$ if and only if A can be expressed as $A = \sum_{j=1}^{k} \lambda_j A_j, \sum_{j=1}^{k} \lambda_j = 1, \lambda_j \ge 0, j = 1, 2, \ldots, k.$ where k is a positive integer, and $A_1, \ldots, A_k, \in S$.

Input and output reference index and current index data (A_j, B_j), $j = 1,2,, \ldots n$ can also be observed; it can be shown to manage possible sets by forming a convex combination V as

$$V = \left\{ (A, B) | \sum_{j=1}^{n} \lambda_j A_j = A, \sum_{j=1}^{k} \lambda_j B_j = B, \sum_{j=1}^{k} \lambda_j = 1, \quad \lambda_j \ge 0, j = 1, 2, \ldots n \right\}. \tag{12}$$

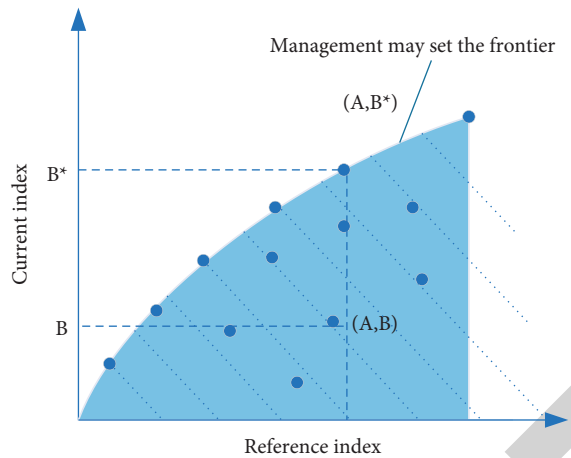

Figure 2: Managing possible sets and their frontiers.

It can be seen from the analysis that this conclusion is not established, the main reason is that in the set $\sum_{j=1}^{n} \lambda_j A_j = A, \sum_{j=1}^{k} \lambda_j B_j = B$ are all equality constraints, and the assumptions governing inefficiencies in possible sets do not hold. Constrain the equality in the set $\sum_{j=1}^{n} \lambda_j A_j = A, \sum_{j=1}^{k} \lambda_j B_j = B$ convert to Inequality Group Constraints $\sum_{j=1}^{n} \lambda_j A_j \leq A, \sum_{j=1}^{k} \lambda_j B_j \geq B$ and assume $(A_0, \sim B_0) = 0, 0$. So, we can get the set as follows:

$$V = \left\{ (A, B) \sum_{j=1}^{n} \lambda_j A_j \leq A, \sum_{j=1}^{k} \lambda_j B_j \geq B, \sum_{j=1}^{k} \lambda_j = 1, \lambda_j \geq 0, j = 1, 2, \ldots n \right\}. \tag{13}$$

The analysis of this management possible set satisfies all construction assumptions, so the set V successfully constructs the management possible set. The reference index and the current index are regarded as an input and an output, respectively, and the *BC2-DEA* method studied by Banker et al. in 1984 can be used to obtain the management possible set, based on which a measurement model of management effectiveness is constructed. Evaluate effectiveness. It should be noted that when using the DEA model to measure management effectiveness, the input and output in this process are no longer the same as the traditional DEA model, and the results obtained have no meaning of pure technical efficiency. The main reason is that input and output are no longer a production process, but a dynamic change in the level of enterprise performance. The DEA model for measuring the effectiveness of enterprise management is as follows:

$$\max Z = \frac{1}{\eta}, \tag{14}$$

$$s.t. \begin{cases} \sum_{j=0}^{n} \lambda_j A_j \leq A_{j0}, \\ \sum_{j=0}^{n} \lambda_j B_j \leq Z B_{j0}, \\ \sum_{j=0}^{n} \lambda_j = 1, \forall \lambda_j \geq 0. \end{cases} \tag{15}$$

If $Z_0 = 1$ in the above model, it means that the evaluation unit is on the frontier of management of possible V. If Z_0 is the optimal value of the above model, then let $\bar{A}j_0 = A_{j0}$, $j_0 = ZB_{j0}$, it will be found that$(\bar{A}_{j0}, \bar{B}_{j0})$*is* located on the management frontier of the management possible set, that is$(\bar{A}_{j0}, \bar{B}_{j0})$ is the projection of the j-th evaluation unit(A_{j0}, B_{j0}) on the management frontier of the management possible set.

In the management possible set V represented by the shaded area in Figure 2, when $Z_0 = 1$, the evaluation unit (A,B) is located on the front surface of the management possible set V; when $Z_0 > 1$, the evaluation unit (A,B) is not in management On the frontier of the possible set V, (A,B) is the projection of the evaluation unit (A,B) on the frontier of the management possible set V.

The management front of the management possible set is the envelope of the effective index state and shows the optimal relationship between the evaluation unit reference index and the current index. In addition, it also reflects the degree of the gap between the evaluation unit and the management frontier of the management possible set, based on which we can obtain the evaluation value of the management effectiveness of the evaluation unit. Assuming Z_0 is the optimal value of the model. Suppose Z_0 is the optimal value of the formula (15), so we can get: $\eta = (1/Z^0) \times 100\%$.

According to the above theory, the reference index and the current index are regarded as input and output respectively, and the BC2-DEA model is used to calculate the

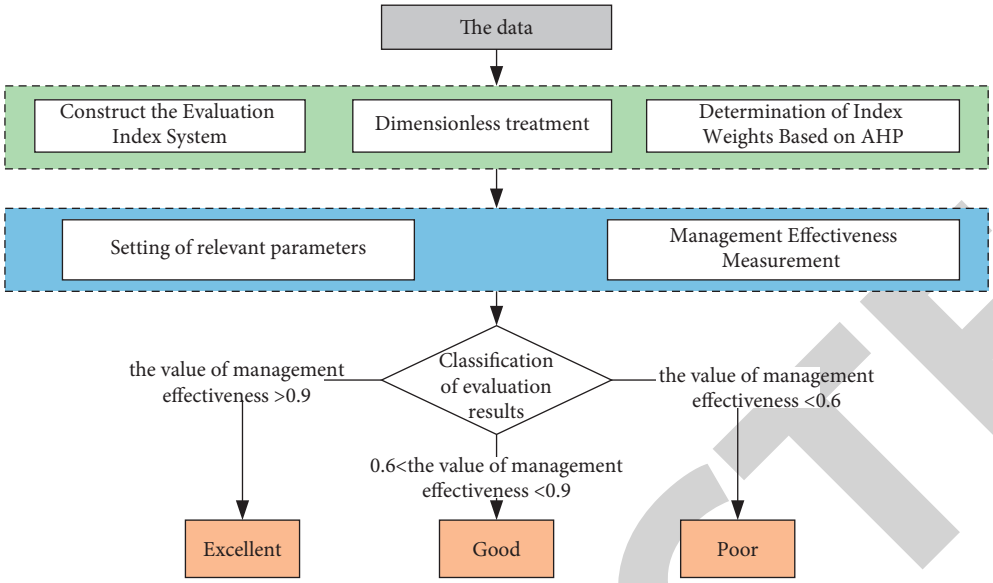

Figure 3: The process of enterprise management effectiveness evaluation based on improved AHP.

management effectiveness. The result of the calculation is the evaluation value of the management effectiveness of the evaluation unit. This evaluation method shows the actual benefit produced by the effective effort level of the evaluation unit under the premise of excluding the difference of objective basic conditions between the evaluation units.

Using the reference index and the current index as inputs and outputs, the evaluation model of management effectiveness is used to calculate the evaluation value of management effectiveness η. The size of η represents the difference coefficient between the enterprise's current management behavior and the best (the evaluation value of management effectiveness). When $\eta = 1$, it means that the current index of the company is on the management frontier of the management possibility set and belongs to effective management; when $\eta < 1$, it means that the current index of the company is not on the management frontier of the management possibility set and belongs to ineffective management.

The process of enterprise management effectiveness evaluation based on improved AHP is shown in Figure 3. Firstly, the evaluation index system was established, and the dimension of the evaluation index system was reduced, and then the AHP was used to determine the weight of the index system. Then the relevant parameters of the management effectiveness evaluation model were used to evaluate the management effectiveness of enterprises. Finally, the effectiveness of enterprise management was measured according to the evaluation structure.

4. Results

4.1. Empirical Samples and Data. This paper selects six enterprises as the research objects, including the primary industry, the secondary industry, and the tertiary industry, with a large scale and multiple subsidiaries. The research object is selected by random method, and the typical enterprises in this province are selected, which has a certain representativeness. According to the established enterprise management evaluation index system, this work used the AHP to analyze the evaluation indicators, the proportion of each index is shown in Figure 4, and the average weight of the index is shown in Figure 5, operation(B3) had the highest weighting, followed by profitability (B1), Marketization (B5), development(B4), and Solvency (B2).

4.2. Management Effectiveness Measurement Results. According to the quantitative value after dimensionless processing and the indicator weights provided, this paper calculates the comprehensive performance scores of the six companies and the performance scores in five aspects. The comprehensive performance of the previous year is the reference index, and the comprehensive performance of the current year is the current index, and the management effectiveness score of each enterprise in the current period is measured. The management effectiveness score is shown in Figure 6.

The averages mask the specific information about the effectiveness of a company in terms of management of firms in their management. Therefore, this paper believes that the management effectiveness of the sample enterprises should be analyzed year by year. The following is a typical analysis of the management effectiveness of sample companies in period t.

Figure 7 shows the reference index, the current index, the frontier ideal value of the current index of the sample companies in the t period. The enterprise 1, 3, 4 has a high level of current management effectiveness, while enterprise 2, 5, 6 has a low level of current management effectiveness. The current index of enterprise management effectiveness in enterprises 1, 4, 5 and 6 is higher than the reference index, indicating that the enterprise management effectiveness has been improved to some extent. The current index of enterprise management effectiveness in enterprises 2, 3 is lower

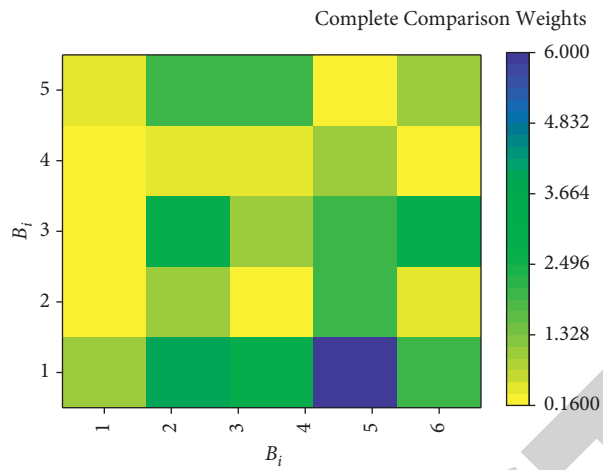

Figure 4: Complete comparison matrix.

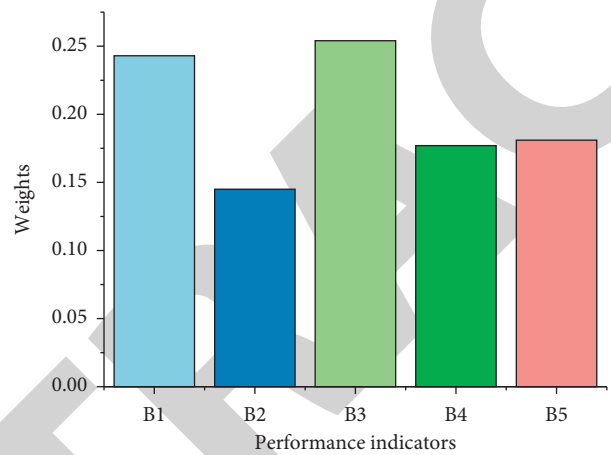

Figure 5: Enterprise performance evaluation index weight.

than the reference index. Figure 8 shows the enterprise management effectiveness evaluation results. According to the analysis results, the enterprise 4 has the highest enterprise management effectiveness, followed by enterprise 6, 3, 1, 5 and enterprise 2 has the lowest enterprise management effectiveness. There is a large difference between the highest and lowest enterprise management effectiveness, indicating that there is a huge difference in enterprise management effectiveness among different enterprises.

According to the size of the evaluation value of management effectiveness, the sample enterprises are divided into the following three categories: the first category is the enterprises with management effectiveness score greater than 0.85 (including 0.85), which belong to excellent management effectiveness enterprises; the second category is the enterprises with management effectiveness score lower than 0.85 and higher than 0.6 (including 0.6), which belong to enterprises with good management effectiveness, and the third category is the enterprises whose management effectiveness score is less than 0.6, which belong to the enterprises with poor management effectiveness. The enterprise management effectiveness evaluation value classification is shown in Figure 9.

According to the above analysis, it can be reflected that the management effectiveness evaluation method fully considers the differences in the objective basic conditions of the units being evaluated. The evaluation value of management effectiveness objectively reflects the effective efforts of enterprise management, and this method can promote the discovery of gaps between companies and companies in the same industry and to tap their own potential capabilities.

5. Discussion

This paper has carried out in-depth research on the management effectiveness of enterprises, and has also achieved certain results. However, the research work of enterprise management effectiveness evaluation has important theoretical and empirical research value, and the research on management theory has certain forward-looking. But there are still problems that need further research: one of the most important evaluation indicators of enterprises is service quality. If customer satisfaction surveys are included in the evaluation system of enterprise management effectiveness, the evaluation of enterprise management effects will be more comprehensive. Although this paper proves the availability

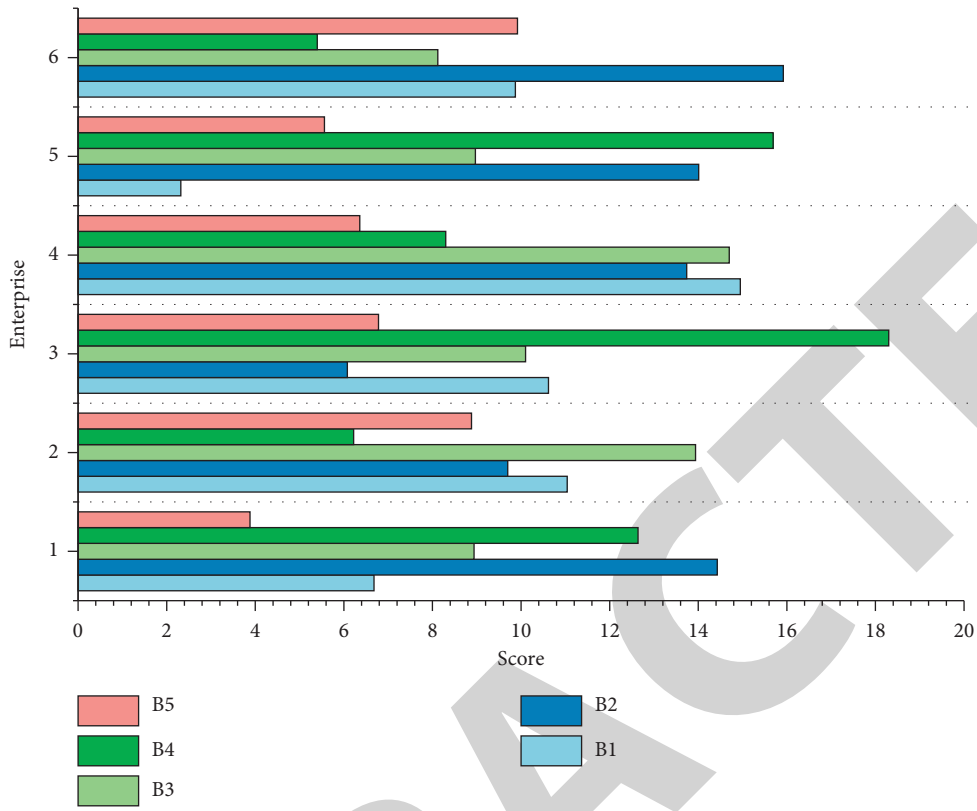

Figure 6: Management effectiveness score.

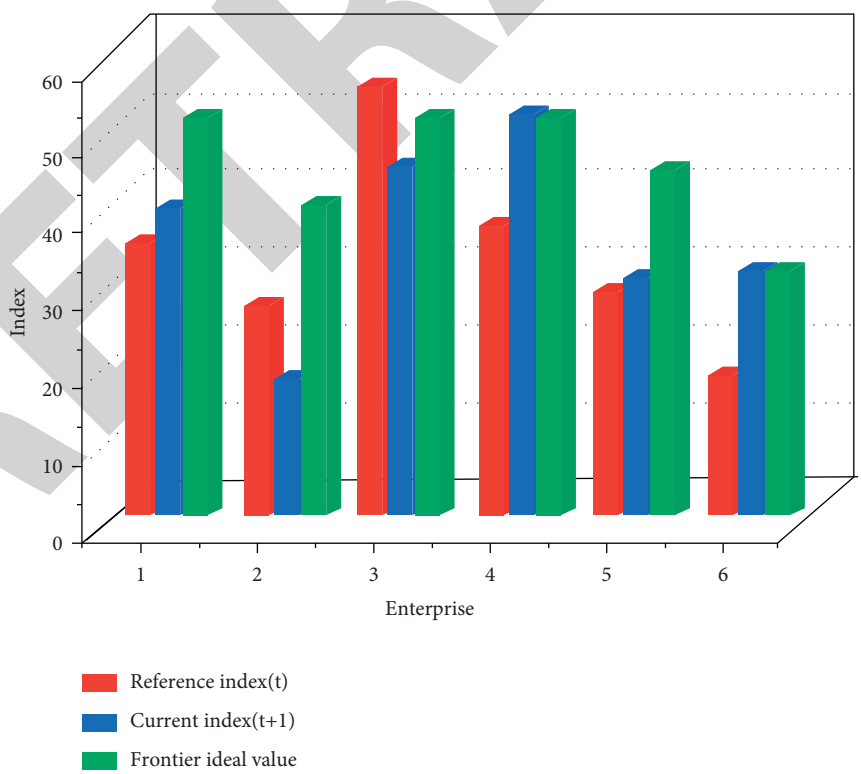

Figure 7: The reference index, the current index, the frontier ideal value of the current index of the enterprise.

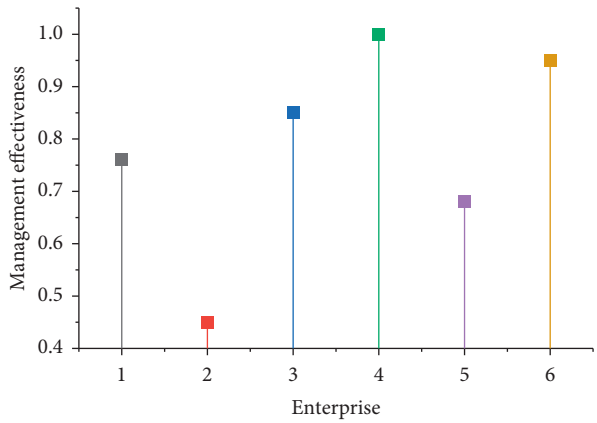

Figure 8: Enterprise management effectiveness evaluation results.

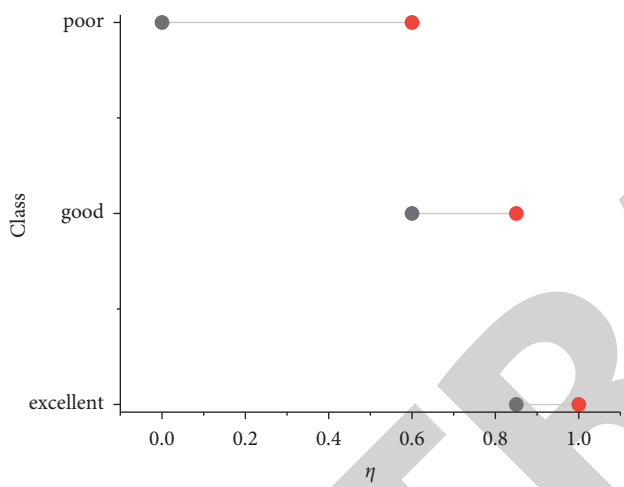

Figure 9: Enterprise management effectiveness evaluation value classification.

of the management effectiveness evaluation model, due to the constraints of many objective conditions, this paper only selects a few enterprises as the research object. This research objects here are only some large enterprises of enterprises. Next, the research perspective should be turned to the study of the management effectiveness of small and medium-sized enterprises.

6. Conclusion

According to the design principle of enterprise management evaluation index system, the enterprise management evaluation index system is constructed from profitability, solvency, development ability, operation ability, and marketization ability. A method of calculating performance that integrates AHP and dimensionless processing is proposed, which is a precondition for evaluating the effectiveness of enterprise management. The evaluation of enterprise management effectiveness based on AHP breaks through the subjective limitation of previous qualitative evaluation and provides guidance for quantitative evaluation of enterprise management effectiveness. Through the interpretation of the management effectiveness theory, and on this basis, the management possible set of the enterprise reference index and the current index is proposed; the enterprise management effectiveness evaluation model is constructed, which provides an effective dynamic for evaluating enterprise management effectiveness. This paper selects six companies as the research object, and conducts an empirical analysis on the management effectiveness evaluation of the sample companies. The empirical results show that the evaluation method of management effectiveness can objectively and fairly describe the pros and cons of the degree of enterprise management.

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 declare that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Analysis of Multimodal Teaching of College English under the Background of Artificial Intelligence

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] L. Niu, "Analysis of Multimodal Teaching of College English under the Background of Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 3833106, 10 pages, 2022.

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Research Article

Analysis of Multimodal Teaching of College English under the Background of Artificial Intelligence

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As the Internet drives the spread of digitalization and the further improvement of computing power, the traditional college English teaching mode can no longer adapt to the needs of teaching in the age of artificial intelligence. Single or lesser modality is gradually replaced by multimodality, an emerging teaching mode. The study of multimodal discourse is a new hot spot in language research and a key issue of concern for English classroom teaching reform. Based on the analysis of the practical application dilemmas of multimodality in college English teaching culture, context, content (meaning + form), and expression, this article proposes a path to innovate multimodal discourse teaching in college English classroom in the era of artificial intelligence. It includes familiarizing with multimode integrated platform for teaching tools and developing intercultural communication abilities. Multimode situational lectures with the help of modern information technology are developed. At the content level, we should adhere to the unity and coordination of the meaning and form of multimodal teaching. Use language and nonlanguage in a way that will enhance learning at the multimode media level. Additionally, AI enriches English teaching methods, changes the intelligence of English teachers, and improves the efficiency of English teaching. AI helps to create a more relevant and interactive English learning environment, improve many aspects of English teaching, including teaching evaluation, and effectively improve the face of college English teaching.

1. AI Technology Overview

Artificial intelligence (AI) is a technological science used to simulate, extend, and expand human intelligence based on big data technology, which has a significant impact on the way people communicate. It makes discourse communication no longer be limited to a single semantic construction and communication modality, but a comprehensive use of auditory, visual, tactile, verbal, image, sound, action, and other ways of multimodal communication. With the advent of the era of AI, the study of multimodal discourse has become a new hot spot in language research and a key issue of concern for English classroom teaching reform.

1.1. History of Development. The important core of AI is algorithm, which can directly promote the generation of AI [1, 2]. According to the historical development and research process, AI has gone through different stages of development from its first generation to the present, as well as the process of algorithm update and development. AI began its phase of full development in the financial industry in the 1960s with the main study of logic [3, 4]. AI commonly used computers to perform intelligent logical reasoning, although this development goal was not achieved in the end. AI developed more slowly after the 1970s and entered a bottleneck period, with little investment made to develop it. In the 1990s, some experts began to work feverishly, and the enthusiasm for AI was rekindled. The intelligence level of computers has developed significantly. It was at this time that the desire to establish a sound computer expert system was realized, but there were relatively little research data available, no relevant experience to establish a scientifically valid computer system, the government stopped supporting research on artificial intelligence, and then the development of AI was again called off [5]. From 1993 to 2011, with the substantial

increase in computing power and data volume, AI technology again began to gain further optimization opportunities and continued to advance AI [6, 7]. The amount of data and computational power have increased dramatically since the development of artificial intelligence, effectively helping AI to use machines for learning and research, especially in the field of deep learning dominated by neural networks. The development of deep neural network-based technology has only gradually entered a period of rapid development [8].

1.2. Technical Composition. AI technology is specifically briefly described as follows.

1.2.1. Big Data. Big data can also be called massive information and mainly refers to the variety and richness of information resources that can have very strong judgment, keen observation, and precise use of process capability only when new data processing methods are carried out.

1.2.2. Computer Vision. Computer vision generally uses a camera and a computer to replace the human eye to identify and track the target to be processed in real time and then make scientific measurements to make some specific graphic processing, so that the processing can be completed more easily and accurately than using the human eye to observe the image.

1.2.3. Speech Recognition. Speech recognition refers to the whole process of recognition, analysis, and understanding by machines, and the clear conversion of speech signals into specific words or relevant commands, which is a new high technology and generally includes three main aspects, namely, information extraction technology, pattern matching principles, and relevant training patterns [9]. Speech recognition requires human and computer to cooperate with each other, focusing on solving the hearing problem of robots, so that robots can clearly hear what people say. The most advanced technology in the development of artificial intelligence up to now is speech recognition.

1.2.4. Natural Language Processing. Natural language processing in general can be divided into two aspects: one is natural language understanding, and the other is natural language production, which can realize the language communication between human and computer, which needs to let the computer understand some specific meaning of natural language well and use the language text to accurately express the meaning and thought and emotion of the language [10, 11]. Natural language processing is a more important development goal that can be better integrated into computer science in the field of AI development.

1.2.5. Machine Learning. Machine learning needs to make the machine have a strong learning ability like human. Studying how the computer simulates to accomplish the learning behavior of the machine, to get more knowledge and expertise of learning, reintegrating the existing knowledge, and then continuously optimizing and improving the performance of various uses of the machine is the most important part of artificial intelligence.

2. Research Framework of Multimodal Discourse Analysis Theory

Multimodal discourse analysis theory can be traced back to the French sociologist Barthes' image rhetoric. British linguist Halliday extended the social sign of language to multiple modalities such as image, action, and sound for language research [12, 13]. In the 1990s, multimodal discourse analysis emerged, and American and Dutch scholars argued that multimodality is including language, technology, image, color, music, action, gesture, body language, and facial expression from multidimensional interaction and cognitive framework, respectively [14]. Chinese scholars investigated the relationship between multimodality and foreign language teaching earlier, and expounded the theoretical basis, teaching design, functional classification, application fields, and development prospects of the relationship between multimodality and foreign language teaching. This represents the latest research results at this stage in China. Scholars agree that with the in-depth development of big data, artificial intelligence, Internet of things, cloud computing, mobile Internet, and block chain, multimodal research and application will become the focus of linguistics, and at the same time, multimodal research will have an important role in promoting the development of AI [15, 16]. The difficulty lies in the need for AI to consider the synergistic operation of different modalities in its design and further optimize the language of AI to make it capable of expressing emotion and attitude in interpersonal communication.

The root cause of multimodal discourse is the development of technology, especially the application of computers [17, 18]. The basic "food" for AI is massive amounts of data, and the backbone is computing power, with the total amount of global data reaching 44 ZB in 2020 and the number of connected devices reaching about 50 billion worldwide [19]. The computing power of the world's supercomputers has increased by a factor of 100. The integration of various advanced yet complex instructions and rules is enabling deep knowledge that is driving AI to reach the same level as humans in some areas [20]. Examples include image testing, sound recognition, and reading comprehension, and are the context in which multimodality is arising. Although AI is a very mature concept, almost all developments in the field have been realized in the last 20 years. Therefore, researchers are all contemporary scholars in recent years, with Halliday, a famous British linguist, founding systemic functional linguistics, and Martin, a famous Australian linguist, founding language evaluation theory and positive discourse analysis theory. On this basis, Chinese scholar Zhang Delu first proposed a multimodal discourse theory in 2009, whose comprehensive theoretical framework mainly consists of a system of four levels: culture,

context, content (meaning + form), and expression, and their sub-categories (see Figure 1). The current development of AI is very rapid, which puts forward higher requirements for multimodality in English teaching, and this theoretical framework has positive guiding significance for us to study multimodal teaching in English classroom.

3. Evaluation Criteria of Multimodal Discourse and Practical Application Dilemma

AI is not only the replacement of humans by trained machines to do a specific job, but also a more precise definition of machines with self-awareness and autonomy to find solutions, i.e., autonomous learning + setting overall goals. In the era of AI, multimodality is standardized in the linguistic community.

3.1. Criteria for Evaluating Multimodal Discourse

3.1.1. Number of Modality Criterion. Discourse that uses two or more modalities at the same time is a commonly accepted criterion in the current linguistic community. Typically, modalities are visual, auditory, tactile, olfactory, and gustatory modalities. Discourse in one modality is called "monomial discourse," such as listening to the radio in the auditory modality or reading a book in the visual modality [21]. A "bimodal discourse" is a discourse that uses both modalities at the same time, e.g., a PowerPoint lesson in which the visual and auditory modalities are used simultaneously. A discourse that uses two or more modalities at the same time is called a "multimodal discourse," e.g., a television and telephone system that can acquire sound, text, data, and images at the same time.

3.1.2. Symbolic System Standard. A modality contains two or more symbolic systems. For example, radio involves only auditory modality but contains background music; comic strip involves only visual modality but contains text and pictures.

3.2. The Dilemma of Practical Application of Multimodality in College English Classroom. In real life, education, art, diplomacy, cultural communication, etc., can use multimodality or multiple symbolic resources to solve practical problems. In university English classroom, the discourse study and teaching of language symbols alone can no longer meet the cognitive needs of students. There are some dilemmas in the practical application.

3.2.1. At the Cultural Level, the Concept Is Old-Fashioned and Lacks a Systematic Multimodal Teaching Concept. With the development of information technology, the application of AI has gradually penetrated various fields, and the way of communication between people has undergone a radical change. In some fields, the generation of multimedia and network has promoted the study of multimodal discourse, and the main modality of communication has shifted from language to image or other modalities. The reason why multimodal teaching is not fully popular in current English language teaching is that there is insufficient application of the specific cross-cultural practices of multimodal modes of teaching. The cultural dimension, which determines communicative traditions, communicative forms, and communicative techniques, is the key dimension that makes multimodal communication possible [22]. The cultural context contains both ideology and genre. Ideology is the sum of ideas, thoughts, values, and other elements of understanding and perception of things, while genre is the communicative procedure or structural potential of ideological realization. In English teaching, many teachers cannot keep up with the speed of development of information society, are not willing to accept new things, have old teaching concepts and ideas, and lack systematic multimodal teaching concepts. Single or fewer modalities make the whole classroom atmosphere depressing and not active enough, teachers struggle to teach, and students learn tediously. Generally, the following formula can be used to predict the mathematical relationship between teaching concept and teaching effect. Based on the above calculation formula, Figure 2 shows the histogram of the relationship between teaching effectiveness and teaching diversification coefficient (taking two group A and group B as the calculation objects, in order to make the data more reliable). As can be seen from the figure, with the diversification of teaching modes, the effectiveness of teaching is more remarkable, and students are more interested in learning.

$$\begin{aligned} E &= a\chi^{\theta} + b, \\ \chi &= \beta\eta, \end{aligned} \tag{1}$$

where E is the teaching effectiveness; θ represents the diversity index of teaching mode;; a and b represent the coefficient related to teaching effect; χ is the value of teaching model; η is the classroom student activity; and β represents the diversified teaching guidance.

In addition, language is both a carrier of culture and ideology and a medium of communication. With the success of the industrial revolution, there is a tendency for Western culture to be sanctified [23]. In the past, teaching has focused too much on the explicit ideology of political education and neglected the implicit role of "curriculum ideology" in English education. As for Western culture, the majority of young students have a weak judgment and a tendency to absorb it all without discriminating. Therefore, the teaching of "curriculum thinking and politics" in college English is of great significance to the establishment of moral education, especially the enhancement of cultural confidence.

3.2.2. Contextual Level, Ignoring the Creation, and Lack of Actual Communication Opportunities. The five skills of listening, speaking, reading, writing, and translating in college English are limited by the contextual factors including the scope of discourse, tone of discourse, and manner of discourse. In the traditional English classroom teaching mode, teachers ignore the creation of contexts and students lack

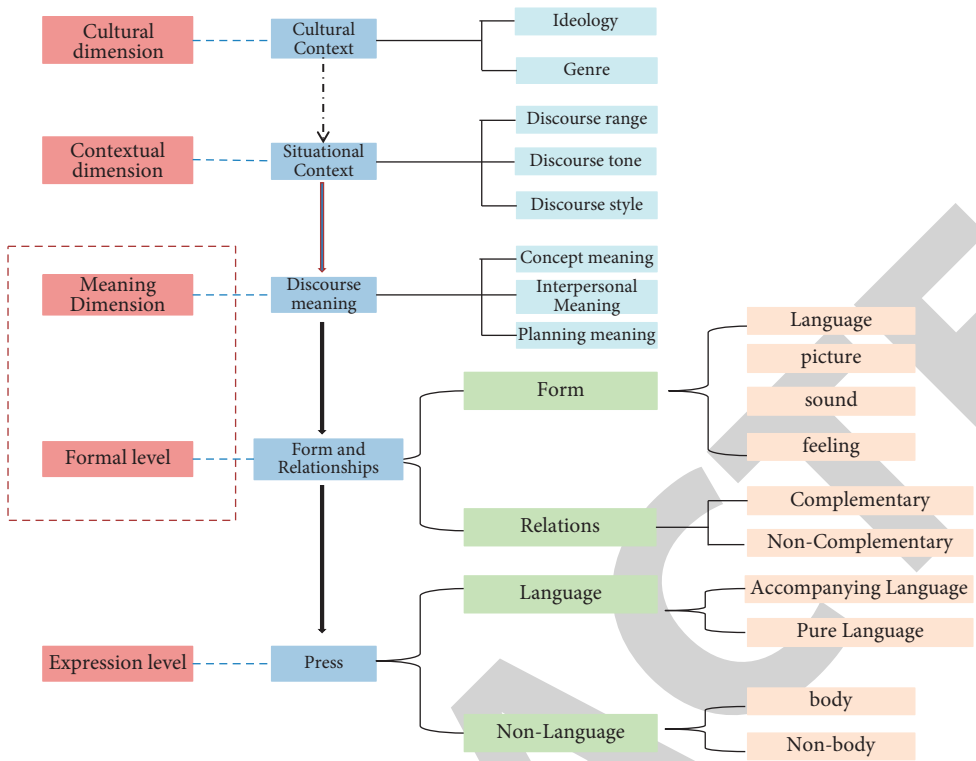

Figure 1: A framework for multimodal discourse analysis.

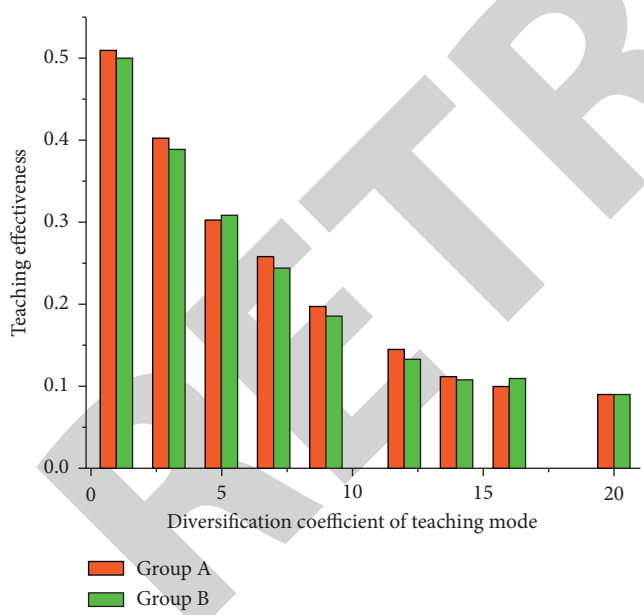

Figure 2: Histogram of the relationship between teaching effectiveness and diversification of teaching modes.

communicative opportunities. In the era of "Internet +" artificial intelligence, educational technology has been fully developed and expanded, teaching methods and teaching means have been gradually innovated, foreign language education has been upgraded to a four-dimensional model of "language + curriculum + technology + people," and their mutual cooperation has formed a four-dimensional ecological network of foreign language education. Their mutual cooperation forms a four-dimensional ecological network of foreign language education. So, the relationship between the effectiveness of foreign language teaching and AI under the four-dimensional model can be described by the following formula. Figure 3 shows a scatter diagram of the relationship between foreign language teaching achievement index and the degree of AI under the four-dimensional model. As can be seen from the figure, with the popularization and wide application of a four-dimensional model of "language + curriculum + technology + people," their mutual cooperation has formed a four-dimensional AI in teaching scenes, the effectiveness of foreign language teaching has increased linearly. In particular, the full extension in time and space has a profound impact on foreign language education, even a subversive revolution. In the era of artificial intelligence, English teaching of listening, speaking, reading, writing, and translation can be simulated in realistic contexts, and the application of multimodal technology can produce multidimensional reorganization of teaching time, space, audience, and resources. For example, "online + offline" and "catechism + microlesson + flipped classroom" can realize the creation of cross-time and space contexts, which are the products of the deep integration of technology and curriculum, and are also the development direction and basic picture of language teaching in the future.

$$W_x = \frac{\varepsilon_x + \varepsilon_y}{2} + \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \varepsilon_x \varepsilon_y},$$
$$W_y = \frac{\varepsilon_x + \varepsilon_y}{2} - \sqrt{\left(\frac{\varepsilon_x - \varepsilon_y}{2}\right)^2 + \varepsilon_x \varepsilon_y}, \quad (2)$$

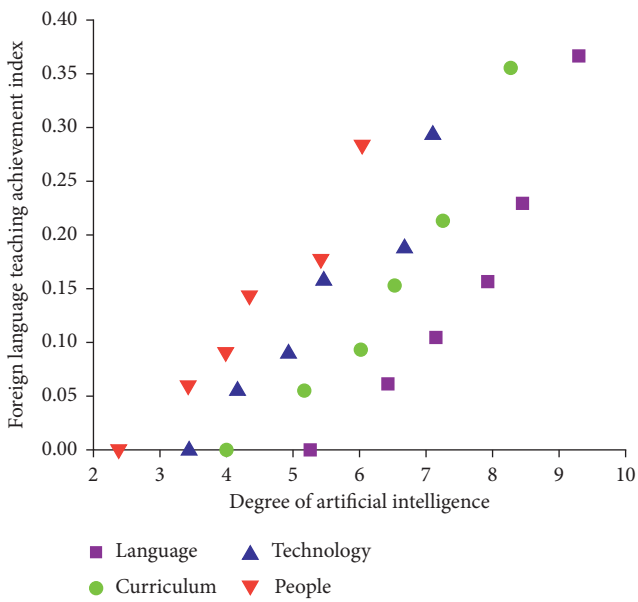

Figure 3: A scatter diagram of the relationship between foreign language teaching achievement index and the degree of AI.

where W is the teaching effect index under the four modes of foreign language teaching; ε represents the degree of artificial intelligence; and x and y represent the corresponding values under teaching methods and teaching scenes.

3.2.3. Content Level (Meaning Level and Form Level), Discourse Meaning Determination, and Form System Selection and Relationship Synergy. The content level consists of "discourse meaning" and "forms and relations." The "meaning of discourse" can be divided into conceptual, interpersonal, and schematic aspects, which are governed by the context of the situation. "Form and relationship" consists of "form" (linguistic, graphical, acoustic, sensory) and "relationship" (complementary, noncomplementary). In English language teaching, the conceptual, interpersonal, and discursive meanings need to be determined, but there is also a focus on the multifaceted communication of information. The formal features of the different modalities are interrelated and together reflect the meaning of the discourse. Multimedia education: A more engaging and convenient environment for learning English is provided through CDs, multimedia teaching materials, and online resources, which also make it easier for teachers to plan and deliver lessons [24]. However, each modality, such as visual grammar, auditory grammar, and tactile grammar, has its own formal system; i.e., the visual and auditory grammars are not definite in fixed language grammar, but have considerable subjectivity. It is difficult to achieve coordination, union, and complementarity between the various modalities.

3.2.4. Expression Level and Effective Use of Verbal and Nonverbal. Language and nonlanguage are both important means of communication. Language is divided into "companion language" and "pure language," while nonlanguage is divided into "physical" and "nonphysical." The term "pure language" refers to sounds and words. The traditional linguistic forms and main media for meaning transmission are sound symbols and written symbols. The term "companion language" refers to sound, tone, type, and layout. "Nonverbal" refers to "body" and "nonbody." The "body" includes movement, analogy, face, and body. The "nonphysical" includes PPT, audio, Internet tools, and laboratory and simultaneous interpretation room environments.

The main basis for teaching English is "pure language." With the development of information network technology and the upgrading of artificial intelligence, the "companion language" will play an auxiliary, supplementary, and reinforcing role in the transmission of language meaning through the size, tone, pitch, accent, intonation, sound frequency, sound and font size, shape, color, and spatial layout of the voice [25]. However, some teachers rely too much on multimedia courseware, spend more time preparing it in class, and then read from the text on the PPT in class, or simply play videos without writing on the blackboard. This is a lack of interaction between teachers and students, and teaching resources are not fully utilized. Students' knowledge and skills are simply mastered, lacking active thinking, and teaching objectives are not achieved. The mathematical relation between degree of interaction between teachers and students and teaching resources can be expressed by the following equations. Figure 4 illustrates the histogram of the relationship between the utilization of teaching resources and the degree of interaction between teachers and students in four dimensions, based on the following equations. In addition, the multimedia courseware used by some teachers is too informative, the interaction and alternate switching between various resources is too frequent, and some require cell phones to operate at the same time. The pace is fast, and the forms are diverse, dazzling, and hurried. Focusing only on the surface form distracts attention and leads to the teaching content not being deep enough to achieve the expected effect.

$$\gamma = \frac{T}{G},$$
$$E = \frac{A - A_1}{A} \times 100\%, \tag{3}$$
$$H = E\gamma + a,$$

where γ is the degree of interaction between teachers and students; T represents the quality of teachers; G is the support of classes; A and A_1 represent the total teaching resources and the resources not fully mobilized, respectively; and H is the utilization degree of teaching resources.

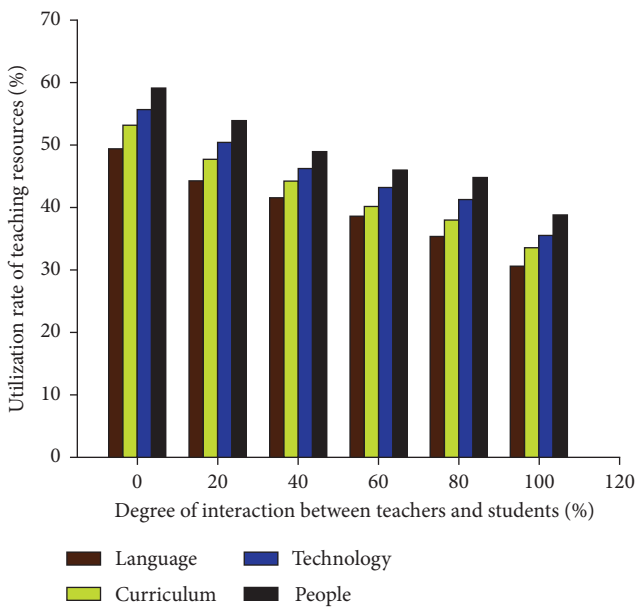

Figure 4: Histogram of the relationship between the utilization of teaching resources and the degree of interaction between teachers and students in four dimensions.

4. The Innovation Path of Multimodal Discourse Teaching in College English in the Era of Artificial Intelligence

4.1. Develop Cross-Cultural Communication Abilities and be Familiar with the Resources Available on Educational Platforms for Multimodal Integration

4.1.1. Be Proficient in Using the Multi-Functional Intelligent Teaching Platform and Advanced Teaching Tools. Simply using Rain Classroom, MicroAssist, and Learning Pass in the classroom will enable multimodal interaction and focus on real-time classroom feedback, and the pop-up function enables instructors to comprehend rapidly the degree of student mastery. Additionally, you can review topics you have already covered with ease because there is a dedicated area for classroom resources. And the rain classroom buddy shake function can also liven up the atmosphere in the classroom question answering. At the same time, college English involves various aspects of science and technology, moral and emotional, cultural knowledge, and social hotspots, which require teachers to adapt to intelligent software tools as soon as possible [26]. For example, in the same lecture on the greenhouse effect, although the teachers could explain in a carefully prepared way in class through a beautiful PPT and a neat blackboard in class, they still used the traditional blackboard to teach, so the students needed to spend a few minutes to understand. Students can grasp at a glance if you employ more sophisticated intelligent classroom technology and 3D software model illustration coupled with motion demonstration. With the use of cutting-edge teaching tools, even pupils with limited English skills will instantly understand the concepts.

4.1.2. Develop Intercultural Communication Skills. The specific components of intercultural communicative competence are four parts: knowledge, ability, attitude, and literacy. In intercultural English teaching, the way to achieve the knowledge goal, ability goal, and emotional goal can be applied to multimodal theory. For example, through a reasonable combination of PPT, language lectures, body movements, facial expressions, English video songs, discussion and Q&A, classroom interaction, microclasses, flipped classroom, etc., the use of sound, text, language, colors, images, movements, expressions, and other modalities can be realized, emphasizing that students learn by "doing," which is conducive to stimulate students' interest in learning. It trains both verbal and nonverbal communication skills and communication strategies.

4.1.3. Focusing on the Construction of English Course Philosophy and Politics. The "curriculum thinking and politics" of university English is responsible for the historical responsibility of "what kind of people to train and for whom to train," which is the fundamental requirement of implementing Xi Jinping's socialist thought with Chinese characteristics in the new era. It is an important embodiment of cultivating national cultural confidence (CNCC), telling the Chinese story (TCS), spreading the Chinese voice (SCV), and explaining the Chinese characteristics (ECC). The mathematical relation between the teaching effectiveness in political English and number of political English teaching courses can be expressed by the following equations. On basis of the equations, Figure 5 shows the spatial histogram of the teaching effectiveness of political English teaching in the above four aspects. It can be seen from the picture that political English teaching has an important impact on teaching effectiveness.

$$\psi_i = \frac{T_i l_i}{G},$$
$$\psi = \sum \psi_i = \sum \frac{T_i l_i}{G}, \tag{4}$$

where ψ is the teaching effectiveness in political English; T represents number of political English teaching; l is the effective class length; G represents the AI improvement coefficient.

4.2. Develop Multimodal Contextual Teaching Methods with the Help of Modern Information Technology.

Context is the environment in which language lives and develops. Because of the established teaching methods in the past, English instruction in China cannot realize the immersive language environment in Europe and America, and it makes it challenging for children to judge if certain linguistic forms are appropriate. More attention is paid to language ability, language knowledge, and language skills, while cultural awareness, thinking quality, and learning ability in English learning are neglected. With the development of AI and 5G, it has become possible for teachers to learn English through multimodal teaching and human-computer dialogue to

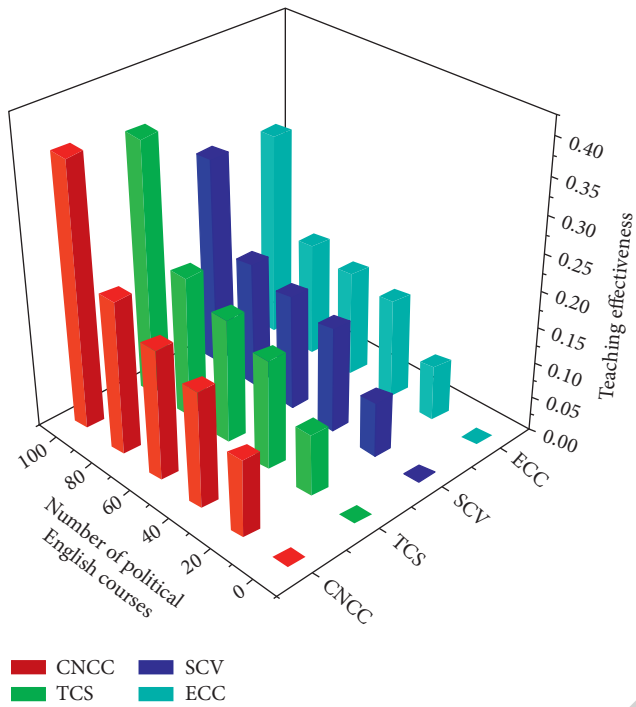

Figure 5: The spatial histogram of the teaching effectiveness and number of political English teaching courses.

create authentic contexts. University English teaching can be based on online teaching resources such as the China University MU platform, WeChat public number MOLS-Net, KU Xunfei *E* Hearing, Mobile Virtual Lab Mlabs, and National Virtual Simulation Experimental Teaching Sharing Platform to realize the teaching empowerment throughout the teaching, learning, examination, evaluation, and management process. With the aid of computer, virtual simulation, and network technology, among other things, it can realize the university English teaching and foreign universities to share educational resources, teaching interaction with foreign teachers and students, and realize the closed context teaching of foreign teachers, excluding outside interference within a certain period of time, so that students' listening, speaking, reading, and writing are fully and systematically cultivated. It is a cutting-edge teaching strategy that combines situational teaching with interactive teaching to pique students' attention and boost engagement in the classroom.

The virtual simulation laboratory of Guangdong University of Foreign Studies is the one with the highest construction standard and specification among similar institutions in China at present. The environment construction of the lab emphasizes teacher-student interaction and group learning, and teaching equipment such as equipment installation, lighting design, acoustic design, teaching tables and chairs, and handwriting boards is designed and arranged around this theme. Figure 6 shows the equipment frame diagram of virtual simulation experiment. For example, the introduction of airplanes through the VR lab, which used to be only flat, can now present the airport and the airplane in three dimensions, even in the

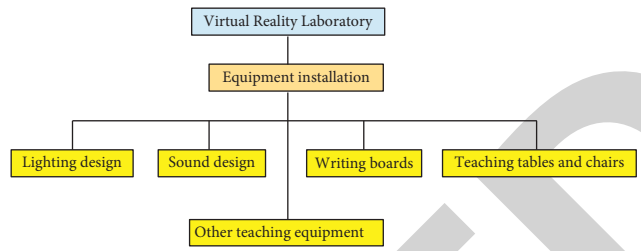

Figure 6: The equipment frame diagram of virtual simulation experiment.

cabin of the airplane. The teacher's class situation can also be instantly and directly transformed into a three-dimensional online course and sent to the cloud platform, thus making it easier for more students to watch it at any time. At the same time, the teacher's class scenario and content can be collected and processed in the background to split and summarize several knowledge points taught by the teacher in the classroom into a micro-course so that students do not have to attend the complete class in order to comprehend the key points they need to learn.

4.3. Content Level Adheres to the Unified Synergy of Multimodal Teaching Meaning and Form. Multimodal teaching content refers to the process of teachers' condensation of teaching materials, using multimedia platform to combine language, images, and sounds to form effective meaning maximization, and instructing students to use these forms of expression for collaborative cooperation and communicative communication. In the process of constructing multimodal teaching meaning, teachers need to do their best in and out of the classroom to explore the meaning and the synergy of forms.

4.3.1. Interpreting Meaning. Students' understanding of the meaning level of English includes vocabulary, syntax, grammar, cultural background, historical customs, and other perceptions. In the teaching process, teachers should introduce the unique meaning or multiple meanings of English vocabulary, grammar, and sentence patterns in different contexts by condensing the teaching materials [27]. Through visual, auditory, and tactile senses, students are enabled to master the basic knowledge of language, consolidate the basic language skills, and develop core literacies such as language ability, cultural awareness, thinking quality, and learning ability in the subject of English.

4.3.2. Tap the Value of English Teaching in the Course of Civic Education. At present, there are problems such as unclear concept, insufficient attention, and rigid way in the English curriculum of university. To be guided by the thought of socialism with Chinese characteristics in the new era, the elements of curriculum thinking and politics should be spring-loaded and silently integrated into English teaching, and the construction of curriculum thinking and politics should be comprehensively promoted. Develop young

students' faith in national culture, as well as better construct Chinese values and promote the Chinese voice while studying and understanding the language. For example, the BBC documentaries "Chinese New Year 2016" and "The Story of China 2016" guide students to correctly understand and systematically study Chinese culture, and realize the relationship between university English teaching and "curriculum thinking and politics." The purpose is to realize the organic integration of university English teaching and "Curriculum Civics," and to realize the purpose of establishing moral education.

4.3.3. Targeted Condensation of the Teaching Style of Famous Teachers Drives and Promotes the Improvement of the Overall Level of All Teachers. A notable teacher's style of teaching is a type of instruction in which the instructor develops distinctive teaching skills and approaches by condensing teaching materials and exploring teaching values in long-term practical activities.

The unity of teaching content and form often has the leading role of unique style and obvious effect. In the process of building multimodal teaching forms, the focus is on guiding practical applications and cultivating students' forward-looking awareness and macroscopic vision. For example, when it comes to foreign holidays, you can live interact or show videos in the virtual classroom to experience the festive scenes abroad. As we all know, the explanation of holidays in English cannot be separated from food, so we can introduce multimodal language information interpretation in visual and taste senses by directly participating in the production of food. For example, teachers try to broaden the teaching content and help students form hotel English thinking, understand the culture of hotel activities through multimodal presentation forms such as school-enterprise cooperation application cases and virtual hotel activity scenes, and train the ability to apply hotel English in a specific linguistic and cultural environment. The relationship between hotel English ability and multimodal language information can be described by the following formula. Figure 7 shows the relationship between the two from the aspects of teaching, culture, thought, and activity. As can be seen from the figure, with the increase of multimodal language information, the ability to apply hotel English also increases.

$$R_{\min} = \frac{\alpha_1 - \alpha_4}{2},$$
$$R_{\max} = \frac{\alpha_1 + \alpha_2 + \alpha_3 + \alpha_4}{4},$$
$$R = \frac{1}{4}\sqrt{(\alpha_1 - \alpha_2)^2 + (\alpha_2 - \alpha_3)^2 + (\alpha_3 - \alpha_4)^2 + (\alpha_4 - \alpha_1)^2}, \tag{5}$$

where R is the hotel English ability; α represents multimodal language information; and numbers represent the aspects of teaching, culture, thought, and activity, successively.

4.4. Language and Nonlanguage Skills Used Well to Enhance the Multimodal Media-Level Learning Experience. In the new round of technological revolution and industrial change with digitalization, networking, and intelligence as the core features, AI and machine learning technologies are fast evolving and affecting how people live, learn, and work, as well as how they are taught and educated. The conventional "pure language" and "nonverbal body language" in the English classroom can no longer fulfill the criteria for teaching, and "accompanying language" and "nonbody language" are needed instead. AI, the Internet of Things, and other technologies are being implemented in depth, and English education has to reform the talent training standards in order to keep up with the times.

4.4.1. Extend the Space with the Help of Platform. In the teaching activities of English, learning materials can be uploaded to social media platforms such as WeChat public number, Weibo, and Tik Tok for display, or even open a special platform for live webcasting. This can enhance the students' sense of situation and strengthen the interactive effect of communication of English knowledge.

4.4.2. Expanding the Multimodal Structure at the Modal Level and Broadening the Teaching Time. Transforming from real classroom teaching to online virtual teaching, more English activities are carried out through intelligent communicative devices, while creating more opportunities for students to communicate and interact in the social network environment.

4.4.3. Optimize the Language of AI to Achieve a True "Student-Centered" Transformation. Traditional education is based on the idea that the teacher is the subject and the student is the object. The creation of modern electronic computers is the simulation of the human brain thinking function and is the simulation of the information process of the human brain thinking. These two aspects together constitute the language of artificial intelligence. It takes the form of structural simulation, which involves the building of "human-like" devices modeled after the human brain, and functional simulation, which involves the simulation of the human brain's functioning activities. In many cases, the application of AI to English translation activities in universities and the teaching of situational simulations with attitudes, emotions, and other interpersonal skills will replace the teacher's knowledge of the students. This will inevitably change the way teachers think and teach, achieving a "student-centered, teacher-led" teaching transformation. Figure 8 shows the thinking map of scenario simulation teaching under artificial intelligence.

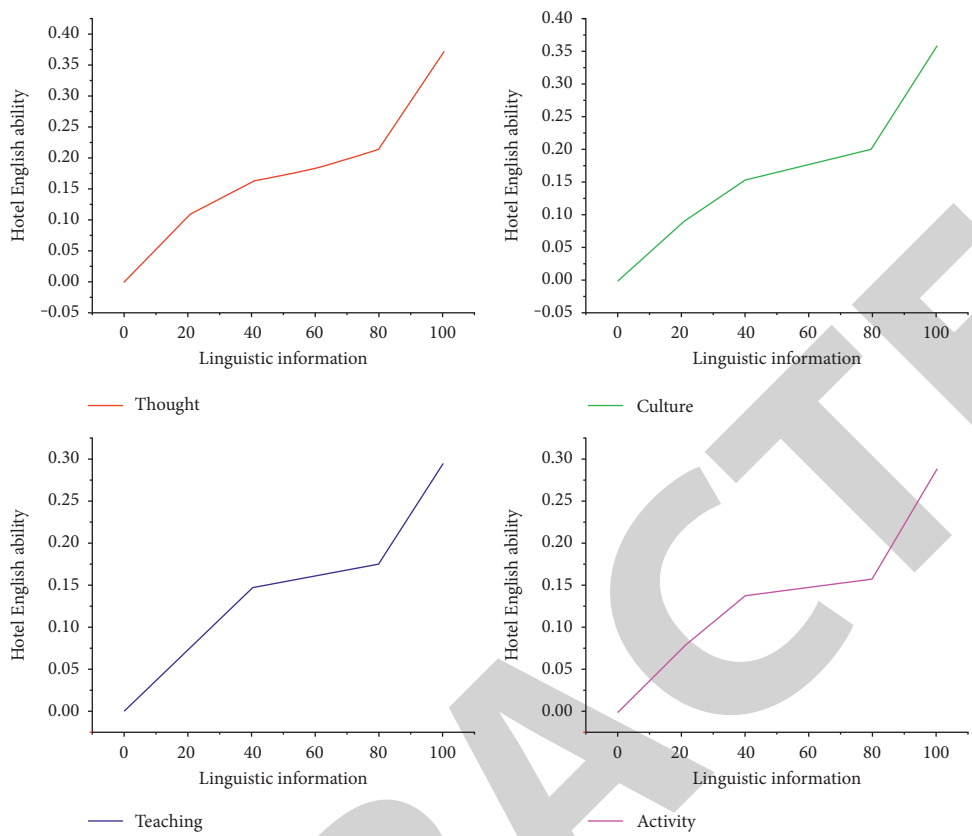

Figure 7: The relationship between hotel English ability and multimodal language information.

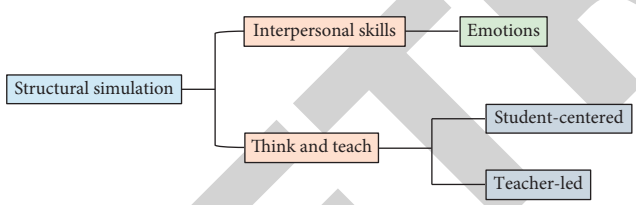

Figure 8: The thinking map of scenario simulation teaching under artificial intelligence.

5. Conclusion

The effectiveness of AI in college English multimodal teaching is affected by many factors, such as users, learning system, and external environmental conditions; the effect produced in practical application has been tested in practice and has a good development prospect, but at the same time, it still needs to be improved to overcome the shortcomings of the system. In view of the problems existing in "multimode college English teaching based on artificial intelligence," based on in-depth investigation and analysis, we draw the following conclusions and suggestions:

(1) At the level of technological development, open up new plates, expand the audience of online education students, and provide learners with learning content in line with their cognitive rules and levels. At the level of learning experience, we should ensure the accuracy and relevance of learning content and improve the autonomy of learning mode.

(2) AI enriches English teaching methods, changes the intelligence of English teachers, and improves the efficiency of English teaching. AI helps to create a more relevant and interactive English learning environment, improve many aspects of English teaching, including teaching evaluation, and effectively improve the face of college English teaching.

(3) In the long run, the combination of AI and teaching will be closer and closer. There is still much room for improvement in resource development, process experience, and result feedback, which will promote more positive changes in college English teaching in the future.

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 declare that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Text Mining of Movie Animation User Comments and Video Artwork Recommendation Based on Machine Learning

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Gong, "Text Mining of Movie Animation User Comments and Video Artwork Recommendation Based on Machine Learning," *Security and Communication Networks*, vol. 2022, Article ID 2800481, 9 pages, 2022.

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Research Article

Text Mining of Movie Animation User Comments and Video Artwork Recommendation Based on Machine Learning

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Video artworks are closely linked with the development of contemporary technology. Therefore, it is widely used in various fields of social life. Video art has become one of the main media forms of contemporary art. In the practice of art teaching, how to combine the existing content of traditional art teaching with video technology and how to understand the inner connection between traditional aesthetics and technological aesthetics have become issues that workers in the new era must think about and pay attention to. As a typical case of influencing works of art, movie animation is loved by the majority of young people. In order to quantify the application effect of machine learning in video art and film animation text mining, this paper conducts prediction research and analysis on several main aspects of color features involved in film animation. By introducing three typical machine learning methods, this paper analyzes the distribution law of the color features of film animation from the perspective of machine learning and its influence on artistic texts. Specifically, the paper uses machine learning methods as a carrier to predict the performance of multiple main modules of color features in movie animation. The prediction results show that the square of the correlation coefficient corresponding to the extreme learning machine is the largest, and the root mean square error, the mean absolute percentage error, and the median absolute error are the smallest, which shows that the extreme learning machine has the best prediction effect. Therefore, it corresponds to the best prediction. In addition, the comparison between the predicted data and the measured data shows that the relationship between the two is approximately a linear function of $y = x$. At the same time, the fitting calculation shows that the predicted data corresponding to the two main modules of the main color and the color structure in the color feature exhibit a good functional relationship of polynomial functions.

1. Introduction

Video art [1, 2] is closely related to the development of contemporary technology and is widely used in various fields of social life. Video art has become one of the main media forms of contemporary art. In the practice of art teaching, how to combine the existing content of traditional art teaching with video technology and how to understand the inner connection between traditional aesthetics and technological aesthetics have become the main problems encountered in the new era. It can be found that understanding the commonalities and differences between traditional art modeling factors and video art is one of the necessary prerequisites for video art to move from abstract concept to practice. Only on this basis can art be more deeply combined with technology to create excellent video artworks.

Video art includes flowing video, pictures, and digital art; video art is a creative method that uses the reproduction of digital products such as cameras and videos. It starts with a reproduction of an image rather than directly facing the object as in traditional painting. The components of video art include composition, scene, angle, movement, lighting, color, and other factors [3, 4]. For example, the film animation and influence artworks involved in this article are its main components.

Video works carry out comprehensive artistic creation in the field of traditional art. These art categories exist in video works as important content, which requires the support of

the theory of traditional modeling factors. Video works are static and dynamic images. It seeks the traditional modeling factors from the static and dynamic picture language and integrates the traditional modeling factors into the images. However, there is a big gap between the video works of China and developed countries such as Europe and the United States [5, 6]. The reason is that the basic skills of traditional modeling elements are not solid. At the same time, there is a lack of profound theoretical support in the creation. Digital media art is an emerging art form, which is characterized by covering a wide range of art categories and being closely related to real life. With the development of the times, digital art based on machine learning is increasingly used in work projects such as film animation text mining and video artwork recommendation.

The entry of digital elements into artistic activities is the independent choice of video art in the environment of digital media technology. With the popularization of the Internet and the continuous development of digital technology, the creation of digital image art shows a diversified tendency in many aspects. Taking the transformation of digital video art creation concepts and artistic practice as the starting point, art creators conduct in-depth discussions on the diversification of digital video art creation from the four aspects of creation, text, media, and communication.

Video art carries out artistic production activities and aesthetic activities under the condition of digital technology. It shows the continuous practice and innovation of digital video art in creative content and creative methods. The diversified creation of digital video art reflects the consciousness of the concept of artistic creation in the digital context and is the survival strategy of video art in the new historical period. At present, with the wide application of intelligent technology, intelligent algorithms, especially machine learning and other methods, are applied in the creation and practice of digital video art.

The creative subject of digital video art breaks through the creative central position of the traditional creative subject's meta-discourse. The main body of creation is from independent to scattered and from one to multiple. The final work created by digital technology for artistic production is not a mechanical reproduction under the cultural industry but a work that changes. Even, such a processing mode did not get the final work at all. Fundamentally speaking, this is caused by the diversification and gradual decentralization of creative subjects. In this case, the creative subject should be called the creative participant. The creative subject of digital video art does not shy away from the creative motive of artistic creation outside of art. The main body of traditional art creation is motivated by "feeling" and finally produces artistic and creative labor results. However, the main body of digital image art creation generally regards art creation as a link in the production process of artworks. In addition, the creative subject of digital video art has established a time-space and nonlinear creative aesthetic principle that is different from traditional art in the process of creation.

In fact, in the initial transition from works to texts, it is not the conversion itself that needs to be dealt with but the relationship between the creative subject, the work, and the receiving subject. In the traditional sense, "text" usually refers to literary works that have not been tested by readers. However, a text is not the same as a work. It should be pointed out that the work is published, and the text is the prelude to the work. From the perspective of artistic creation, the main difference between traditional video art and digital video art lies in the degree of participation in the creation of texts. For traditional art, participation seems to exist only in acceptance. In a digital context, however, participation also exists in creation. From the technical source, the significant difference between digital video works and traditional video works is the existence of bitization. In the actual operation process, digital technology can be used to produce, present, and project video works, which is convenient for the modification, improvement, preservation, and transmission of texts. Moreover, with the assistance and blessing of machine learning, the development of video artworks is more promising.

As a manifestation of video artworks, film animation [7, 8] is favored by most people. Especially for teenagers, film animation brings joy and motivation to their growth. In China, the main consumer groups of movies and animation are still children and teenagers. There are many problems with Chinese film animation, especially the review text for film animation. These issues mainly include the following points.

First of all, TV animation and film animation are not very different in production [9, 10]. As a result, their content could not be better at engaging the audience. Secondly, children do not have high requirements for viewing places, sound effects, and playback screens. For children, watching TV animation on the sofa at home is not very different from watching animation in the theater. Therefore, no matter in content or form, there are no special viewing needs for children. To cultivate children's habit of watching movies, it is necessary to learn the experience of mature theater facilities in developed countries abroad. For example, animation theaters in the United Kingdom are usually built inside entertainment centers. When consumers choose entertainment, they usually choose to watch movies, which also increases the attraction of children to movie theaters. In order to solve the above problems encountered by the Chinese film animation industry, this paper intends to solve the problems existing in its development and cognition from the perspective of machine learning in order to improve the text mining ability of film animation users. Because the research area involved in the recommendation of video works and the text review of movie animation is too large, this paper takes the research aspect of color feature retrieval of movie animation as an example to conduct follow-up analysis and research.

2. Color Feature Retrieval of Movie Animation Based on Text Mining

The traditional movie animation material retrieval usually adopts the index-based method. However, the number of animation materials in the material library is huge, and this

method will cause a waste of manpower and time and cannot achieve satisfactory results.

In the process of making a movie, it is very necessary to quickly retrieve the required material. The traditional index-based animation material retrieval methods cannot meet the requirements of film workers in terms of efficiency and accuracy. To this end, researchers urgently need a fast and accurate way to find material [11, 12]. The content-based multimedia retrieval method can solve such problems.

International Standard—MPEG-7 provides a complete set of multimedia content description tools, further developed into content-based description and retrieval specifications. It stores the content characteristics of images or sounds in a fixed format. Animators can store animation material in MPEG-7 standard format in advance and provide it to the retrieval system to achieve the effect of fast retrieval. As shown in Figure 1, MPEG-7 mainly achieves the material mining of movie animation texts through three aspects: color features, texture features, and comprehensive retrieval.

Since the existing animation material is usually a shot, the shot is composed of a series of image frames with little visual change. Therefore, the animation material can be retrieved by retrieving key frames. In the MPEG-7 standard, color and texture descriptors are usually used to extract features of such static images. In the process of making animation, a single descriptor is used to describe the content of the animation color, and the retrieval effect obtained by the experiment is not very ideal. The main work of this paper is to combine the advantages of these two types of descriptors to conduct model experiments. The experimental results show that the precision and recall of comprehensive retrieval are improved compared with single descriptor.

As the most basic and most expressive visual feature of images, color has the characteristics of relatively clear definition and relatively easy extraction. Color-based image retrieval has also received extensive attention. In the actual operation process, the color representation of the movie animation can be represented by the color acquisition signal. As shown in Figure 2, the color signal, similar to the vibration signal, also exhibits multiple peaks and valleys. These curve extrema points represent the change threshold points for the color of the movie animation. That is, specific characterizations of several key color regions can be obtained from the results of signal analysis.

In order to clearly obtain the information contained in the color signal, it is necessary to perform signal processing on the signal. At present, the analysis methods for such nonstationary signals mainly include Fourier transform, wavelet analysis, wavelet packet analysis [13, 14], and Hilbert transform [15, 16]. Among them, the Fourier transform is mainly suitable for linear steady-state signals. However, it is not very suitable for nonstationary signals like Figure 2. Wavelet analysis breaks through the form of the Fourier transform window function, and it can change the size of the window function in real time. In this way, the wavelet transform can improve the adaptability of the algorithm to nonstationary signals. Compared with wavelet analysis, wavelet packet analysis continues to decompose the high-frequency band and improves the high-frequency resolution of the signal. But it is undeniable that the accuracy of wavelet packet analysis has a huge relationship with the choice of wavelet basis function.

The Daubechies wavelet [17, 18] series has good compactness, smoothness, and symmetry, so it is widely used in unsteady signal processing. For the same color signal, db5~db10 are used for 9-layer decomposition, respectively, and the reconstruction error is shown in Figure 3. As shown in Figure 3, the reconstruction error of db6 is the smallest, so this paper uses db6 as the wavelet basis function for subsequent research.

Assuming that an n-level decomposition of the signal with frequency ω results in 2 n sub-bands, with each sub-band width being $\omega/2$ n,

$$x(t) = \sum_{j=0}^{2^n-1} x_{n,j}, \tag{1}$$

where $x_{n,j}$ is the reconstructed signal corresponding to the jth frequency band of the nth layer, $j = 1,2,3,\ldots\ldots,2^{n-1}$.

Let $E_{n,j}$ represent the signal energy value corresponding to the frequency band of $x_{n,j}$ which gives the following:

$$\begin{aligned} E_{n,j} &= \int \left| x_{j,i}(t) \right|^2 dt \\ &= \sum_{k=1}^{m} \left| z_{i,k} \right|^2, \end{aligned} \tag{2}$$

where $z_{i,k}$ is the amplitude corresponding to the discrete points of the sub-band sub-band, k is the number of discrete points, and m is the length of the collected data.

The total vibration energy of the signal can be expressed as follows:

$$E = \sum_{j=1}^{2j} E_{n,j}. \tag{3}$$

The energy percentage of each frequency (T n, j) band can be expressed as follows:

$$T_{n,j} = \frac{E_{n,j}}{E}. \tag{4}$$

The signal is decomposed into 9 layers using the "db6" basis function. According to formulas (1)–(4), the wavelet packet energy calculation is carried out through the MATLAB platform. The energy percentages of the sub-bands are shown in Figure 4. As shown in Figure 4, the spectrum analysis results of the vibration signal involved in this paper show that the signal energy distribution range is large, and the main energy distribution is within 0~200 Hz. At the same time, the main frequency band of the signal energy is located within 140~150 Hz.

In order to systematically explain the application effect of the comment text of movie animation, this paper studies the color features involved in movie animation. The acquisition of color features is mainly obtained through the wavelet

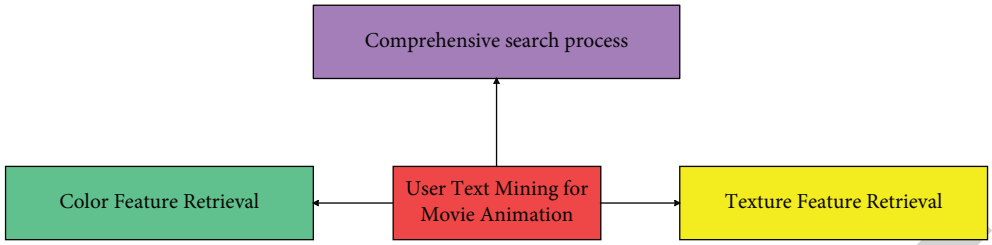

Figure 1: Comprehensive retrieval process based on MPEG-7.

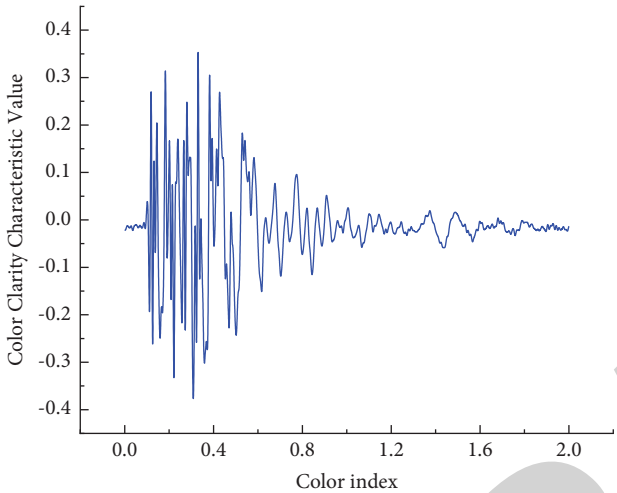

Figure 2: Characteristic curve of color characterization value.

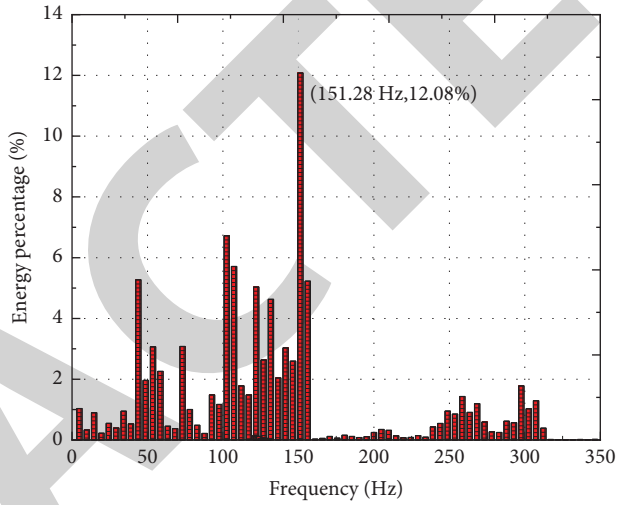

Figure 4: The energy spectrum of e signal of color.

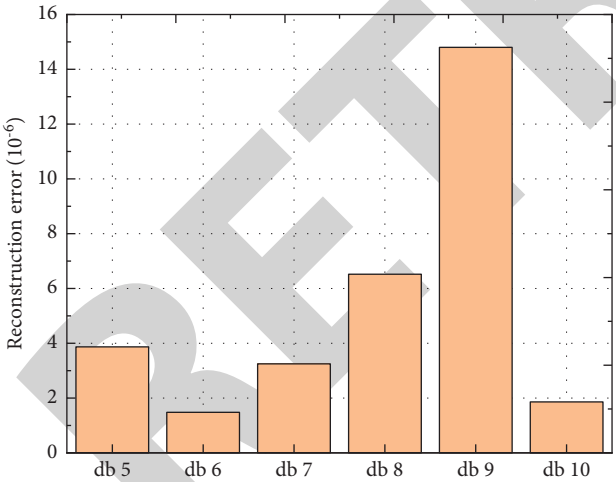

Figure 3: Reconstruction error of wavelet packet decomposition.

packet analysis of the color representation signal. The main wavelet packet analysis process can be obtained by formulas (1)–(4).

In the production of animated movies, there are usually not many colorings, and a picture uses several or a dozen color information, and according to habits, the most important information often appears in the center of the picture. Because the primary color descriptor is mainly used to describe the distribution information of the salient colors in the image, its purpose is to provide an effective, compact, and intuitive color representation for the region of interest. Therefore, it is most suitable for representing local salient color features.

With the third wave of artificial intelligence sweeping the world, artificial intelligence has once again become the focus of the whole society. It should be pointed out that machine learning, as a representative technology of artificial intelligence technology, is widely used in various scientific research fields. It can be found that the research on film animation evaluation from the perspective of machine learning is of great significance for systematically mining film texts and recommending works of art.

With the advent of the era of big data, various application fields are inseparable from artificial intelligence technology, especially the assistance and blessing of machine learning technology. The innovation and development of user reviews for movie animation are no exception. Artificial intelligence has the unique advantages of not being limited by time and space, fast duplication and dissemination, and rich in presentation effects. It can provide a new experience for the recommendation of video artworks and a wide range of intelligent tools and information service platforms for the evaluation of movie animations.

In the specific operation process, four types of scenery including sunset, water waves, flowers, and white clouds can be randomly selected from the scene material library in the animation material library as the research object. During the experiment, 30 key frames (representing 30 shots) were

selected for each type of scene, a total of 120 key frames, as the basic database of the experiment. During the experiment, the key frames of each type of subject scene will be used as the image to be retrieved. In addition, the database is searched using the primary color descriptor as a key.

The subsequent framework of this paper can be expressed as follows: first, several commonly used machine learning techniques can be introduced, and their arithmetic and application scopes are introduced, respectively. Then, relevant researchers take the rapid retrieval of color features in movie animation as the research goal and conduct systematic research on the involved color representation indicators. Finally, through the introduced machine learning algorithm, predictive analysis and comparison are carried out.

3. Elman Networks

As the most commonly used machine algorithm, neural network is widely used in various research fields. Among them, BP neural network [19, 20] has the widest application range. In this section, the author studies its prediction effect by introducing a branching algorithm of neural network, Elman neural network.

Neural networks are widely used for their large-scale parallel distributed structure, learning ability, and generalization ability. The main advantages are nonlinear analysis capability, convenient input/output mapping, adaptive capability, evidence response, background information, strong fault tolerance, VLSI (Very Large Scale Integrated) implementation, analysis and design consistency, and neural biological analogy. This paper takes Elman neural network as an example to describe the implementation process of traditional neural network prediction in detail.

The calculation process of the Elman network can be expressed as follows.

For the input layer, the Elman network can be represented as follows:

$$x_i^0 = x_i(k). \tag{5}$$

Here, x_0 represents the input variable of the input layer and x_k represents the output variable of the input layer obtained after the nonlinear calculation of the neural network.

For the hidden layer, the Elman network can be expressed as follows:

$$\begin{cases} s_i^1 = \sum_{j=1}^{n^0} w_{ij}^0 x_j^0(k) + \sum_{j=1}^{n^1} w_{ij}^2 c_j^0(k), \\ x_i^1 = f1\left(s_i^1(k)\right). \end{cases} \tag{6}$$

For the association layer, the Elman network can be expressed as follows:

$$\begin{cases} s_i^2(k) = x_i^1(k-1), \\ c_i(k) = s_i^2(k). \end{cases} \tag{7}$$

For the output layer, the Elman network can be represented as follows:

$$\begin{cases} s_i^3(k) = \sum_{j=1}^{n_1} w_{ij}^1 x_j^1(k), \\ y_i(k) = f2\left(s_i^3(k)\right). \end{cases} \tag{8}$$

Similarly, the implicit value in the network can be expressed as follows:

$$\begin{aligned} -\frac{\partial E(k)}{\partial w_{ij}^0} &= -\sum_{l=1}^{r} \partial E(k)/\partial y_l(k) \cdot \partial y_l(k)/\partial w_{ij}^0 \\ &= \sum_{l=1}^{r} e_l(k) \cdot f2'\left(s_l^3(k)\right) \cdot w_{ij}^1(k) \cdot \partial x_i^1(k)/\partial w_{ij}^0. \end{aligned} \tag{9}$$

Through comprehensive calculation, we can get the following:

$$\begin{cases} -\frac{\partial E(k)}{\partial w_{ij}^0} = \sum_{l=1}^{r} e_l(k) \cdot f2'\left(s_l^3(k)\right) \cdot w_{ij}^1(k) \cdot \chi_{ij}^i(k), \\ \chi_{ij}^i(k) = f1'\left(s_i^1(k)\right) \cdot \left(x_j^0(k) + \sum_{m=1}^{n_1} w_{\mathrm{im}}^2 \cdot \chi_{ij}^m(k-1) \right), \end{cases} \tag{10}$$

The key to the nonlinear ability and learning ability of the network lies in the continuous correction of the weights. There are two methods for recurrent network training: one is batch mode and the other is online mode, where Elman network adopts the latter.

4. Extreme Learning Machine

Extreme learning machine [21, 22] is a special form based on support vector machine. Compared with the traditional one-dimensional support vector machine, it simplifies the prediction problem into a single-hidden-layer feedforward neural network based on the regression principle of least squares. The research results show that the prediction effect of extreme learning machine is better. In the design of extreme learning machines, researchers can use kernel functions instead of computational hidden layers that contain many nodes. The computational procedure of extreme learning can be expressed as follows:

$$e_j = \sum_{i=1}^{H} \alpha_i f\left(w_i, c_i, x_j\right) \; j = 1 \ldots N, \tag{11}$$

where w represents the weight of the input layer and α represents the weight coefficient of the input layer. In the formula, c represents the weight coefficient of the hidden layer and X represents the input independent variable matrix.

The weight coefficients corresponding to the input layer are randomly generated. It satisfies the continuous probability distribution based on Gaussian. The weight layer of the input layer of (9) can be expressed as follows:

$$\lambda = (B + Y). \tag{12}$$

Here, B and Y represent the independent variables related to the extreme learning machine, respectively, and λ represents the dependent variable obtained by linear calculation of the independent variables.

In the formula, two independent variables and one dependent variable can be expressed as follows:

$$B = \begin{bmatrix} j(x_1) \\ \cdot \\ j(x_N) \end{bmatrix} = \begin{bmatrix} g(w_1, c_1, x_1) \dots g(w_H, c_H, x_1) \\ g(w_1, c_1, x_j) \dots g(w_H, c_H, x_j) \end{bmatrix},$$
$$\lambda = \begin{bmatrix} \lambda_1^T \\ \cdot \\ \cdot \\ \lambda_H^T \end{bmatrix}, \tag{13}$$
$$Y = \begin{bmatrix} y_1^T \\ \cdot \\ \cdot \\ y_N^T \end{bmatrix}.$$

5. Prediction Based on the Fuzzy Neural Inference System

The neural reasoning system [23, 24] is a system composed of three components, which mainly include (1) rule base, (2) database, and (3) reasoning system. In the fuzzy neural inference system, the input parameters consider different fuzzification and defuzzification methods and strategies and have various rules. This intelligent algorithm can choose from many sets of member functions to ensure the effect of fuzzy logic on the input data. The fuzzy inference system can be divided into three inference modes according to the "if-then rule" inference operation. These inference modes are Mamdani system, Sugeno system, and Tsukamoto system, respectively. Sugeno system is considered to be the most popular candidate for sample-based fuzzy modeling and facilitates the use of adaptive techniques. In a one-dimensional Sugeno system, a typical rule set with two computational rules for fuzzy inference can be expressed as follows:

When $x = A_1$, $y = B_1$, then the fuzzy neural inference system can get the following:

$$f_1 = \alpha_1 x + q\beta_1 y + \eta_1. \tag{14}$$

Here, f_1 represents the function value obtained by the fuzzy neural inference system and α_1, β_1, and η_1, respectively, represent the undetermined coefficients related to the function output.

Similarly, when $x = A_2$ and $y = B_2$, the fuzzy neural inference system can get the following:

$$f_2 = p_2 x + q_2 y + r_2. \tag{15}$$

Here, f_2 represents the function value obtained by the fuzzy neural inference system and α_2, β_2, and η_2, respectively, represent the undetermined coefficients related to the function output.

Figure 5 is a schematic diagram of the workflow of the fuzzy neural network prediction system.

6. The Application of Machine Learning in Movie Animation User Reviews and Text Mining

With the continuous development of information technology, animation technology is used more and more in movies. The animation special effects made by computer can already reach the level of fake and real. It is no exaggeration to say that more than 95% of modern films have animation elements to some extent.

After the production of each film, the film production company will collect useful materials to form the company's material library so as to use the previously accumulated materials when making new films, which will greatly shorten the production cycle of new films, improve work efficiency, and reduce invest. With the rapid growth of the number of materials in the material library, how to quickly and accurately find the required material in the increasingly huge material library has become a difficult problem for animators. Film animation, as a branch of film technology, also has similar problems. In order to quantify the research of machine learning technology in influencing works of art, this paper mainly uses machine learning to identify the color features involved in film animation. Based on the color descriptor in the MPEG-7 standard, this paper applies it to the retrieval of film materials and achieves good experimental results.

The feature of color is the most basic and most expressive visual feature of an image. It has the characteristics of relatively clear definition and relatively easy content extraction, so the color-based image retrieval has been widely valued and applied. Color description in MPEG-7 mainly includes main color, scalable color, color structure, color space, and color layout. The main color descriptor is mainly used to describe the distribution information of the salient colors in the image. Its purpose is to provide an efficient, compact, and intuitive color representation for regions of interest.

The color layout descriptor can represent the spatial distribution of the color semaphore in the whole image, and it has a small computational cost while searching efficiently. This descriptor supports the user's hand-drawn sketch query in the image query system, which is not available in other descriptors. It is very effective in image quick browsing and search applications. This paper adopts the method of combining manual retrieval and automatic retrieval. The searcher sets the corresponding weights according to the content of the key frame to be retrieved as the main color descriptor and the isomorphic texture image descriptor. It should be noted that the size of the weight will affect the retrieval results. Considering that the production of animation is an artistic creation, the subjective feeling of the

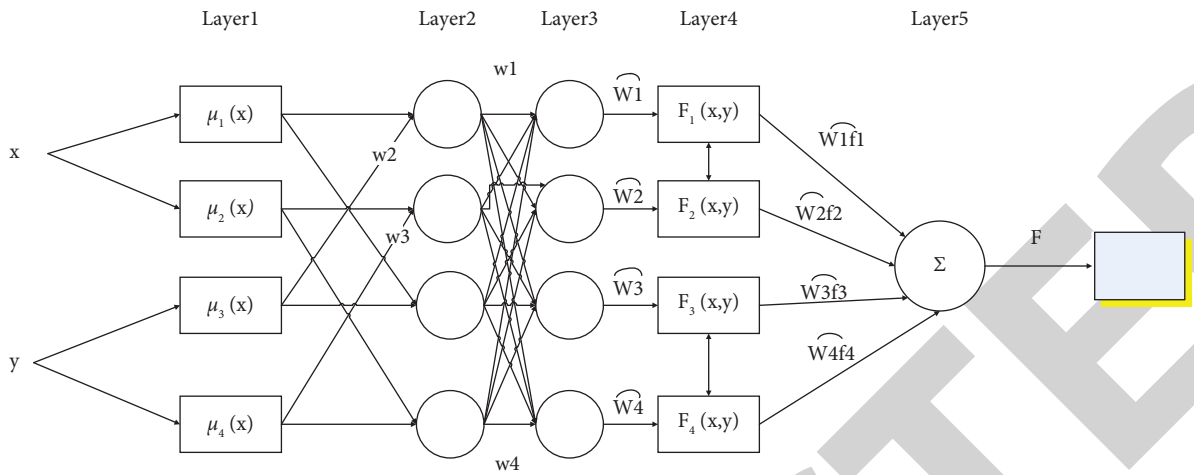

Figure 5: Elman network structure diagram.

producer also plays an important role. It is up to the producer to decide whether the key frames to be retrieved are important for color information or texture information.

Although the retrieval of animation key frames by combining color and texture features has achieved good experimental results, this method also has limitations. A large number of experimental results show that if it is a key frame of pure scenery, the retrieval effect will be better with color features. This requires the searcher to flexibly set the weights of the color and texture descriptors according to the actual situation in the search process so as to achieve better search results. In order to solve the above problems, this paper uses the three machine learning algorithms mentioned above to optimize and predict several main target values involved in the movie animation retrieval process. In order to express clearly, the three machine learning algorithms are mainly Elman networks, extreme learning machine, and fuzzy neural inference system.

Through the three machine learning methods mentioned above, the specific indicators of the five color features involved in the text mining research of movie animation reviews are predicted and studied. It is well known that the square of the correlation coefficient (R^2), the root mean square difference (RMSE), the mean absolute percentage error (MAPE), and the median absolute error (MEDAE) are several typical machine learning predictors. The next research plan is to evaluate the prediction effect of several machine learning techniques by comparing the square of the correlation coefficient, the root mean square error, the mean absolute percentage error, and the median absolute error of the three algorithms. It is well known that the closer the square of the correlation coefficient (R^2) is to 1, the smaller the root mean square error, the median absolute error, and the mean absolute percentage error, indicating higher prediction accuracy. Table 1 shows the prediction performance of the three machine learning methods of Elman networks, extreme learning machine, and fuzzy neural inference system. Among them, RMSE, MAPE, and MEDAE can be obtained by the following formula:

$$\begin{aligned} \mathrm{RMSE} &= \sqrt{\frac{1}{n} \times \sum_{i=1}^{n} \left| \left(y_i - x_i\right)^2 \right|}, \\ \mathrm{MAPE} &= \frac{1}{n} \times \left[\sum_{i=1}^{n} \left| \left(y_i - x_i\right)/y_i \right| \right] \times 100, \\ \mathrm{MEDAE} &= \mathrm{median}\left(y_i - x_i\right). \end{aligned} \tag{16}$$

It can be seen from Table 1 that the square of the correlation coefficient corresponding to the extreme learning machine is the largest, the maximum value is 0.9851, the root mean square difference is the smallest, and the minimum value is 0.1569. This comparison result shows that the prediction effect corresponding to the extreme learning machine is the best. In addition, the prediction performance of the three machine learning techniques is ranked from strong to weak as follows: extreme learning machine, Elman networks, and fuzzy neural inference system.

At the same time, the above analysis shows that extreme learning machine can be used as a representative machine learning technology in innovative research on movie animation user reviews and text mining.

In addition, in order to more systematically evaluate the prediction effect of machine learning technology, the three-dimensional contour cloud map of the prediction data obtained based on the extreme learning machine is drawn in Figure 6. As shown in Figure 6, the prediction results of the color features involved in movie animations and video artworks obtained by machine learning have good continuity.

In order to further prove the prediction effect of machine learning technology on the color features involved in movie animation, we plot the prediction results of several feature variables of movie animation color retrieval in Figure 7. As shown in Figure 7, the functional relationship between the predicted value corresponding to the movie animation and the measured value is approximately a linear function relationship. The specific functional relationship expression is

Table 1: Comparison of prediction performance of three big data technologies.

Machine learning technology	The effect of regression analysis			
	Squared correlation coefficient (R^2)	Root mean squared difference (RMSE)	Mean absolute percentage error (MAPE)	Median absolute error (MEDAE)
Elman networks	0.9238	0.2011	0.3011	0.3669
Extreme learning machine	0.9851	0.1569	0.1201	0.0990
Fuzzy neural inference system	0.8674	0.268	0.2901	0.1821

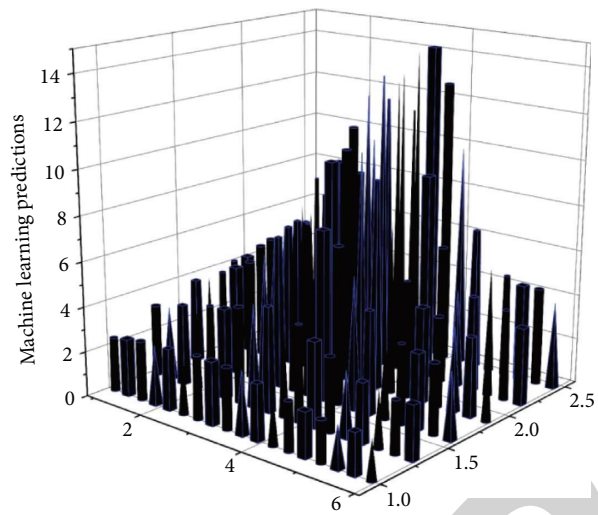

Figure 6: Continuity of prediction effect based on extreme learning machine.

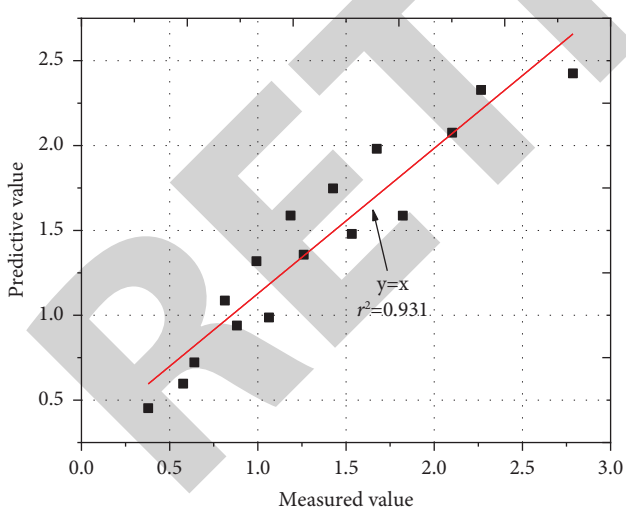

Figure 7: The comparison between the measured value and the predicted value.

$y = x$. From Figure 7, we can see that the coefficient of determination between the predicted value and the measured value is 0.931, and the prediction accuracy is high.

The functional relationship between main color and structure of color is studied by means of data fitting as shown in Figure 8. As shown in Figure 8, there is a certain polynomial function relationship between the two.

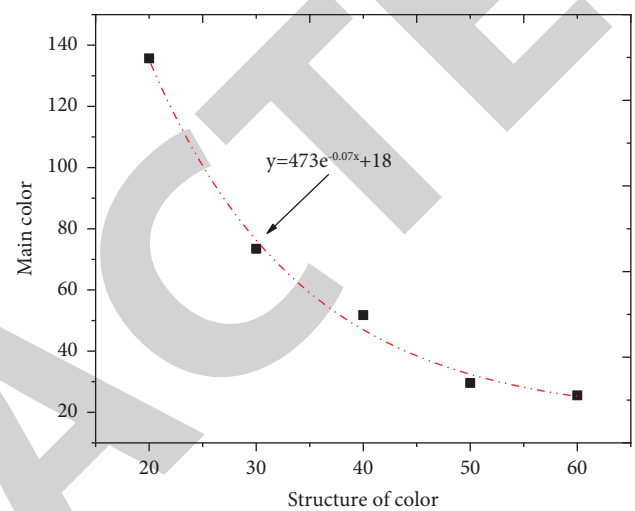

Figure 8: Data fitting relationship between main color and structure of color.

7. Conclusion

Video art has technical genes since its birth, and video artworks are the crystallization of multiple creative ideas under the blessing of digital technology. It is undeniable that the interpretation of the creative concept and creative practice of digital video art from a diversified perspective is an urgently needed evaluation scale for the art theory circle in the digital age. As a special form of video artworks, film animation is loved and respected by the majority of young people. The application of machine learning in the text mining process of movie animation is promising. In order to quantify the evaluation index of movie animation, this paper uses the color feature retrieval involved in movie animation as the research to carry out machine learning. The article introduces three different machine learning techniques based on Elman networks, extreme learning machine, and fuzzy neural inference system. Then, the main aspects of main color, scalable color, color structure, color space, and color layout involved in the color characteristics of movie animation can be predicted and analyzed. The prediction effect shows that for the research cases introduced in this paper, the prediction effect obtained by extreme learning machine is the best. Its root mean square deviation is only 0.1562. The square of the correlation coefficient is the largest, and the maximum value reaches 0.9851. In addition, the comparison results between the predicted data and the

Hindawi
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Retraction

Retracted: Analysis and Application of Data Mining Technology for College English Education Integration

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

In addition, our investigation has also shown that one or more of the following human-subject reporting requirements has not been met in this article: ethical approval by an Institutional Review Board (IRB) committee or equivalent, patient/participant consent to participate, and/or agreement to publish patient/participant details (where relevant).

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Chen, "Analysis and Application of Data Mining Technology for College English Education Integration," *Security and Communication Networks*, vol. 2022, Article ID 6118196, 11 pages, 2022.

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Research Article

Analysis and Application of Data Mining Technology for College English Education Integration

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With the development and application of information fusion technology, English education can realize intelligent application under multi-information fusion technology. In view of the low degree of educational informationization and single application of intelligent methods in the process of education, this paper puts forward the application of multi-technology in English education, so as to improve the education level and application skills. Firstly, this paper explains the educational application technology, especially the analysis of decision tree and linear regression method in data mining technology, and puts forward the framework and system structure diagram of English education system. In the experiment, the application of different methods is compared, and the results show that the decision number method has higher weight in weight analysis. According to the situation of different course quantity, 50%–80% of the course workload can be completed under multi-information fusion. However, in the amount of homework completion, most of the personnel can complete the homework, which has a good application effect. In different English majors, different research methods have different educational purposes and different teaching effects. Through the system interface and system performance testing, using the data mining method has better UI test results and shorter test time.

1. Introduction

With the improvement and enhancement of the education system, college English education has been paid more and more attention by schools. Different English education has different students' learning interests. Using computer information technology to improve students' English scores is a successful way to education. No matter the unilateral education of English or the cultivation of talents, teachers have an irreplaceable position and are considered powerful analysts. Exploring the future development plan and planning of education has obviously become a part of educators. In order to establish the optimal experimental planning and analysis results, it is necessary to practice an important working system to realize the good development of education. With the maturity of network technology and the popularization of multimedia in classrooms, compared with the traditional blackboard teaching, it can no longer meet the high-efficiency dissemination of knowledge, so it is an important measure to implement English teaching reform at present. Reasonable use of computer-related technology has become an effective way for people to receive education; while adapting to modern technology, remember to keep the pace of the times of traditional education. It strengthens the integration of computer high-efficiency skills and English education and realizes the practical policy of teaching integration [1]. It discusses the application of computer technology in college English classroom teaching and gives corresponding solutions according to our own teaching experience [2]. The data index of the integration degree of information technology and foreign language teaching in different periods is experimented, which proves the deep blending between them with the changes of the times [3]. Through flexible and effective teaching methods, students' learning enthusiasm can be mobilized and their autonomous learning ability can be cultivated [4]. It describes the effective dissemination of educational knowledge by teachers in class and puts forward the effective understanding of knowledge by students, which is the key problem of today's education system [5]. It promotes the modernization of college English

education and constructs a systematic English curriculum system [6]. It analyzes the internal causes and functions of landmark achievements in each period and points out the main problems and contradictions in each period [7]. It triggered the reconfiguration and combination of time and space in traditional classroom teaching and changed the structure of traditional classroom teaching [8]. Accurately grasp the deficiency of English writing ability and adjust and remedy it in time, so as to organically realize the purpose of promoting learning by evaluation [9]. It discusses that teaching begins with meaning inquiry and that teaching should pay equal attention to standardization and innovation [10]. It analyzes the common types of translation problems that still exist at present and puts forward relevant improvement strategies [11]. It shows that there are obvious differences in the meanings of English words and sentences expressed in different articles and explains the meanings in them [12]. Combined with the teaching examples of college English reading and writing, this paper expounds the theoretical characteristics and application of the above stages [13]. With the help of classroom to collect students' growth data to realize multiple evaluation and data analysis, it is convenient for teachers to analyze the weak points of students and take corresponding improvement measures [14]. Based on the Small Private Online Course (SPOC) model, the construction of college English flip classroom teaching practice model can provide good support for college English teaching reform [15].

2. Integration Method of Information Technology and English Curriculum

2.1. Information Technology Fusion Method. In the face of the optimization and trend of English education, both teachers and students play an important role. It not only innovates teaching methods but also optimizes teachers' curriculum design and improves teaching efficiency. It promotes the leading role of teachers in classroom teaching. Integrating information technology into English education industry not only enhances it, improves the efficiency of knowledge exchange between students and teachers, and significantly improves the performance of teaching tasks but also enriches the teaching content. The teaching practice is tutored by using systematic tools and experimental methods, which makes students have reverse thinking in all aspects when thinking about problems in the critical period of information education.

2.1.1. Kalman Filter Algorithm. It is described by linear stochastic differential equation [16], as shown in the following formula:

$$X(k) = AX(k-1) + BU(k) + W(k). \tag{1}$$

Formula (2) is as follows:

$$Z(k) = HX(k) + V(k). \tag{2}$$

At time k, $X(k)$ represents the system state; $U(k)$ represents the system control quantity; and $Z(k)$ represents measurement. Among them, the system parameters are A, B, and H; the covariance is Q, R. $W(k)$ is process noise and $V(k)$ is measurement noise.

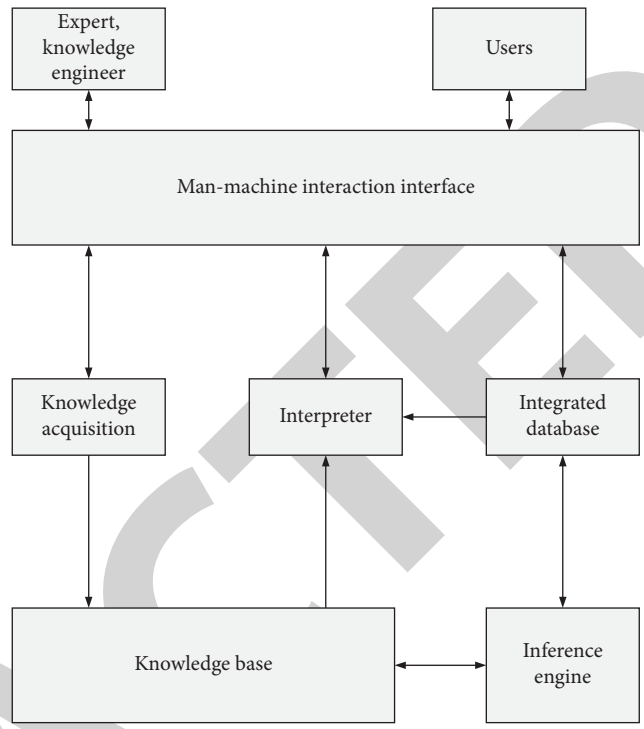

Figure 1: System flowchart.

K is used for predicting the state of the system, as shown in the following formula:

$$X(k|k-1) = AX(k-1|k-1) + BU(k). \tag{3}$$

Calculate the covariance p, as shown in the following formula:

$$P(k|k-1) = AP(k-1|k-1)A' + Q. \tag{4}$$

An optimized estimate $X(k|k)$ of the state $Z(k)$ is calculated:

$$X(k|k) = X(k|k-1) + Kg(k)(Z(k) - HX(k|k-1)). \tag{5}$$

Kg is Kalman gain [17].

$$Kg(k) = \frac{P(k|k-1)H,}{(HP(k|k-1)H, +R)}. \tag{6}$$

Realize the update covariance of $X(k|k)$ in k state, as shown in the following formula:

$$P(k|k) = (l - Kg(k)H)P(k|k-1). \tag{7}$$

2.1.2. Expert System Method. The expert system method is shown in Figure 1.

In Figure 1, the user inputs the corresponding requirements through the human-computer interaction interface, and the system selects the corresponding

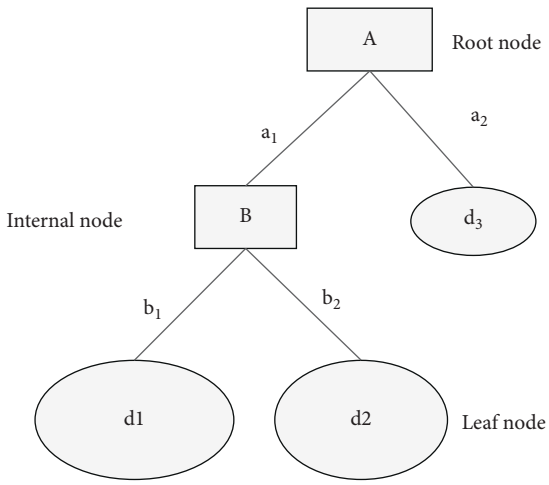

Figure 2: Concept diagram of decision tree.

interactive knowledge base for query according to the user input to obtain the corresponding results. The basic process of the expert system method [18]. is to face the questions put forward by the system from the user, and then to match and upgrade the information after processing, and then to match and store it in the comprehensive database. Finally, the expert system presents the final conclusion to the user.

2.2. The Best Scheme of Matching Information Technology with English Education

2.2.1. Decision Tree Learning Algorithm. Decision Tree [19]. Decision tree is an efficient optimization and decision-making method. The judgment is made from the internal node to the output of the branch result. Finally, each leaf node represents the result of a classification, as shown in Figure 2.

The characteristics of decision tree method are information entropy, information gain, information gain rate, and *Gini* index.

The decision tree process is shown in Figure3.

Entropy [20]:

$$P(X = x_i) = p_i, \quad i = 1, 2, \ldots\ldots, n. \tag{8}$$

Then, the entropy of random variable X is defined as

$$H(X) = -\sum_{i=1}^{n} p_i \log\, p_i. \tag{9}$$

The greater the entropy, the greater the uncertainty of random variables. The distribution of X when values are 1 and 0 is

$$P(X = 1) = p, P(X = 0) = 1 - p, 0 \le p \le 1. \tag{10}$$

The entropy is

$$H(p) = -p\, \log_2\, p - (1 - p)\log_2(1 - p). \tag{11}$$

Conditional entropy [21]:

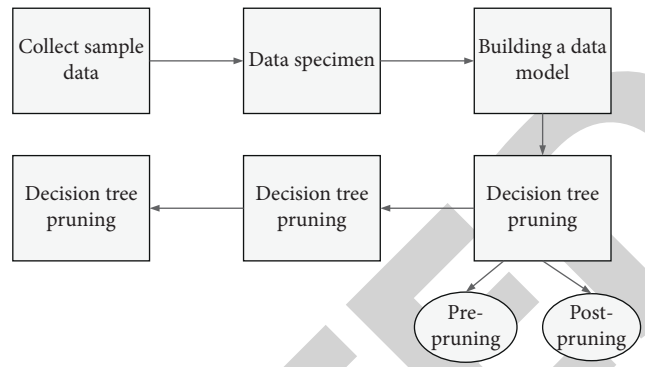

Figure 3: Process flowchart of decision tree algorithm.

$$H(Y \mid X) = \sum_{i=1}^{n} p_i H(Y \mid X = x_i). \tag{12}$$

Ask anonymously: $p_i = P(X = x_i)$, $i = 1, 2, \ldots, n$.

Information gain [22]:

$$g(D, A) = H(D) - H(D \mid A). \tag{13}$$

Algorithm of information gain:

(1) Calculate the entropy of the dataset:

$$H(D) = -\sum_{k}^{K} \frac{|C_k|}{|D|} \log_2 \frac{|C_k|}{|D|}. \tag{14}$$

(2) Calculate the conditional entropy $H(D|A)$:

$$H(D \mid A) = \sum_{i=1}^{n} \frac{|D_i|}{|D|} H(D_i) = -\sum_{i-1}^{n} \frac{|D_{ik}|}{|D|} \sum_{k-1}^{k} \frac{|D_{ik}|}{|D_i|} \log_2 \frac{|D_{ik}|}{|D_i|}. \tag{15}$$

(3) Calculate the information gain:

$$g(D, A) = H(D) - H(D \mid A). \tag{16}$$

Information gain rate:

$$g_R(D \mid A) = \frac{g(D, A)}{H_A(D)}. \tag{17}$$

Gini index [23]:

$$\begin{aligned} Gini(p) &= \sum_{k-1}^{K} p_k(1 - p_k) = 1 - \sum_{k-1}^{K} p_k^2, \\ D_1 &= \{(x, y) \in D \mid A(x) = a\}, \\ D_2 &= D - D_1, \\ Gini(|D| A = a) &= \frac{|D1|}{|D|} Gini(D1) + \frac{|D2|}{|D|} Gini(D2). \end{aligned} \tag{18}$$

Regression tree [24]:

$$\sum_{x_i \in Rm} (y_i - f(x_i))^2, \tag{19}$$

where $f(x_i)$ is a predicted value for each division unit.

$$f(x_i) = c_m = aue(y_i \mid x_i \in R_m). \tag{20}$$

The summation formula is

$$\min_{j,s}\left[\min c_1 \sum_{x_i \in R_1(j,s)} (y_i - c_1)^2 + \min_{c2} \sum_{x_i \in R_2(j,s)} (y_i - c_2)^2\right]. \tag{21}$$

2.2.2. Data Mining Technology. Linear regression [8]:

$$\hat{w} = \left(X^T X\right)^{-1} X^T y. \tag{22}$$

Parameter evaluates to the following expression:

$$\hat{w} = \left(X^W X\right)^{-1} X^W y. \tag{23}$$

The optimization formula is defined as follows:

$$\begin{aligned} &\text{Fit } \theta \text{ to mini mize} \sum iw^{(i)}\left(y^{(i)} - \theta^T x^{(i)}\right)^2, \\ &\text{Output } \theta^T x. \end{aligned} \tag{24}$$

3. Research on Information-Based Education Integration

3.1. Research Method

3.1.1. Literature Analysis. Collect information and read related books, periodicals, and corresponding documents. Reach a solution to the problem according to your own needs. Among them, finding the corresponding research results according to the mastered forecasting needs is to lay the foundation of the basic theory and have a basis for the cycle method.

3.1.2. Content Analysis. Content analysis method will use characteristic evaluation method to realize the most valuable reasoning and analysis when making meaningful article content evaluation. The original text form has been unable to satisfy the powerful interpretation of the text, so the content analysis method to make full use of the text has become an important document analysis method.

3.1.3. Interview Method. It is easy to understand that interviews refer to face-to-face communication between people to achieve the purpose of disseminating information and reaching consensus. From the psychological judgment of different groups of people, we can meet the needs of both sides, which is convenient for observation and judgment in the later period. Understand how people respond to problems.

3.1.4. Statistical Analysis of Data. Data statistical analysis method is to calculate and analyze all kinds of data through corresponding mathematical methods and finally achieve experimental results. Facing the situation of optimization and improvement in the education industry, it is necessary to make a standard education framework to achieve high efficiency and accuracy of education.

3.2. System Requirement Analysis. According to the key training of English education in schools and the key construction plan of the national education system, a computer information management system will be developed to change the teaching mode. Through the coverage and popularization of school education network, it is convenient to enter the campus network at any time, which can increase the rapidity of students' education. Sharing network resources is to improve students' learning ability and reform teaching.

In college English education, some students' basic English ability is weak, and their comprehensive English quality level is not high. According to the difference of English mastery level of poor students and excellent students, teachers can carry out some regional and key education methods to teach. Self-regulated learning and timely strengthening of interest in English subjects are good qualities for students to perform in improving their grades, and they have indispensable spiritual qualities for realizing English education.

Nowadays, the diversification of college English textbooks and the institutionalization of educational examinations have led to increasing pressure on students to receive comprehensive education. In order to adapt to the change of teaching materials, students and teachers should accept traditional culture and supplement their cognition of new knowledge in time. In the face of English problems and difficult problems, we should have unique and intensive practice skills and methods to solve the problems.

3.3. System Technical Architecture. Using data extraction technology to judge the level of students' information will realize the process reengineering of educational network, as shown in Figure 4.

First, the input basic information of students is inserted into the dataset, and the initial data sample set is processed and analyzed. The content of the dataset is clearer to meet the requirements of qualified data samples. The qualified data sample set should be divided into two parts, one is the training dataset, and the other is the test dataset. Both of them use C5.0 classification algorithm to mine and analyze data to build a basic decision tree, so as to achieve the expected judgment of experimental standards. If a good decision tree can be built, the classification principle of text data can be realized, and students' grades can be evaluated. Such a planning flowchart greatly realizes teachers' friendly analysis of students' grades and makes corresponding teaching changes.

The realization of the framework of modern education system has a predictive experiment on curriculum arrangement, which can reflect the importance of students' English education. The overall framework design of the curriculum is shown in Figure 5.

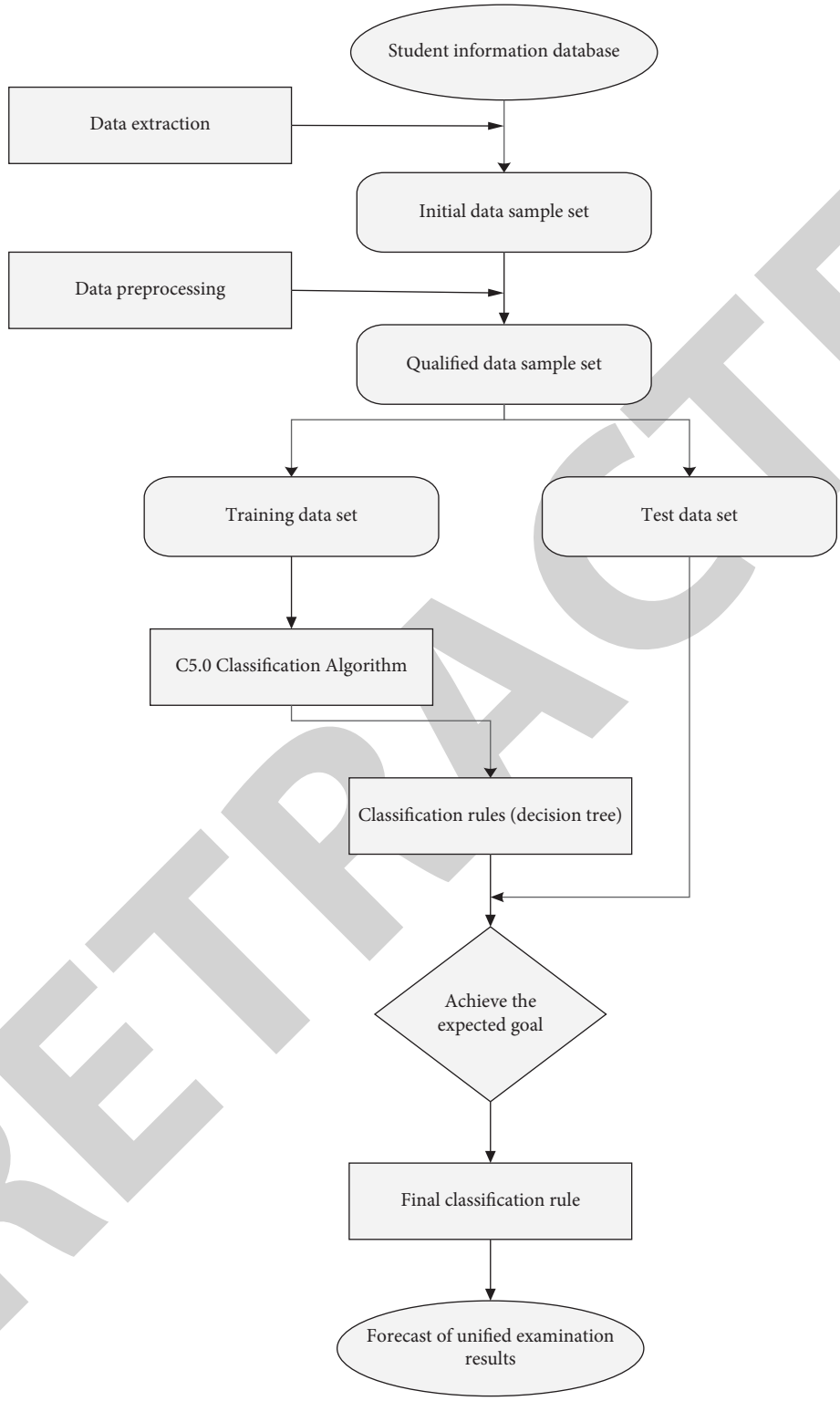

Figure 4: Flowchart of English achievement prediction.

When the system prompts, the user can make corresponding actions and provide feedback to the system. In the performance prediction interface, the user will be evaluated and judged according to the prediction results.

The logic layer mainly deals with the business of the system, including user management, data management, and other basic information management contents. This stage is the main core stage, which plays a key role in reusing performance prediction and plays an important transitional part.

According to the teaching task and teaching arrangement, the processing layer inputs and stores the data, which

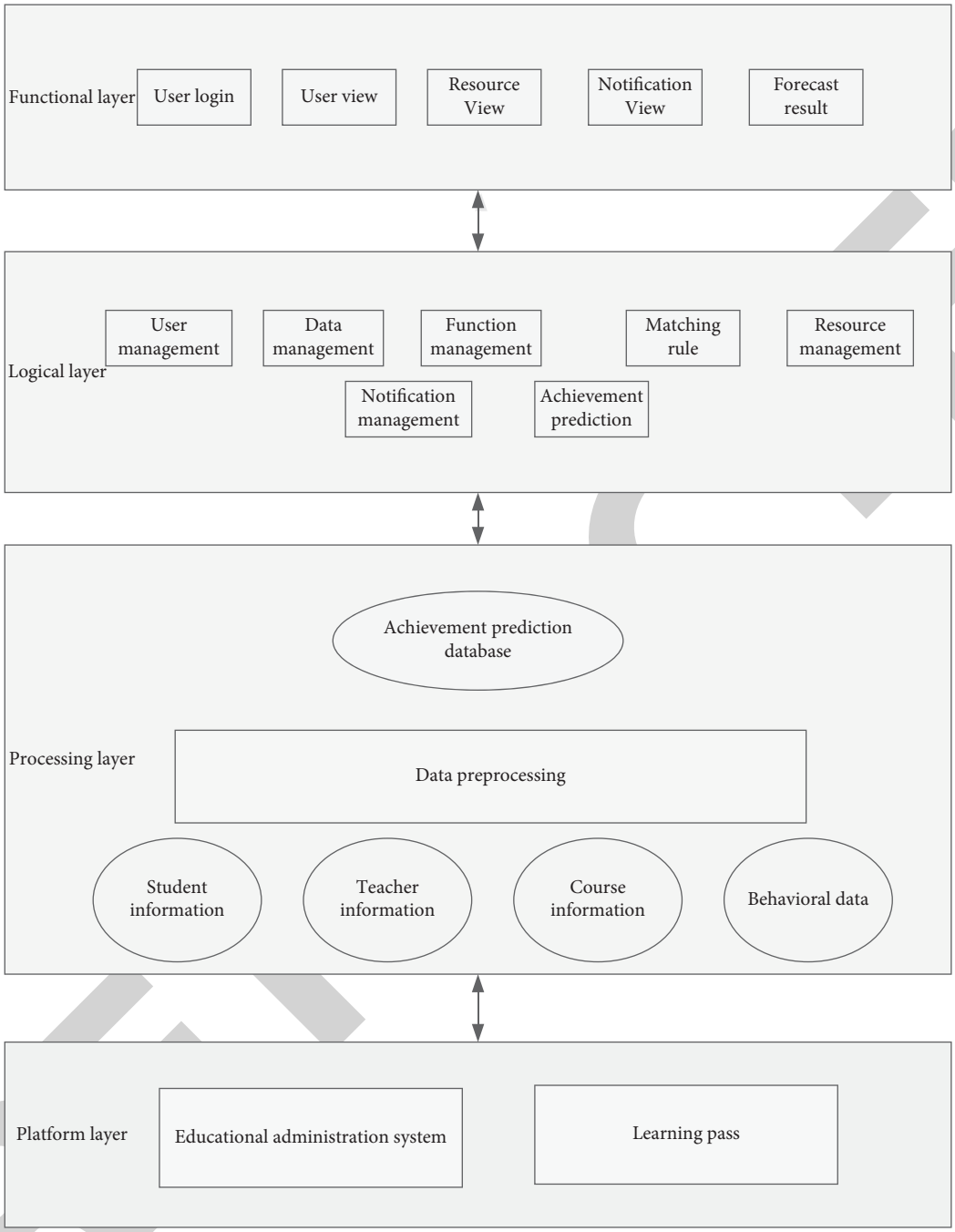

Figure 5: System architecture framework diagram.

is convenient to preprocess the analysis information of the corresponding modules in the database. At this level, the information processing will strengthen the rationalization and practice of data to achieve the perfect embodiment of information data.

Students mine and explore data according to their needs to realize basic research and achieve the educational system concept of educational administration and students.

3.4. System Function Analysis. According to the teacher's education guidance system for students, make corresponding information combination to achieve appropriate education process. At the same time, according to the different ideological systems of teachers and students, we find experts to analyze and judge and finally realize the systematic idea of process reengineering, as shown in Figure 6.

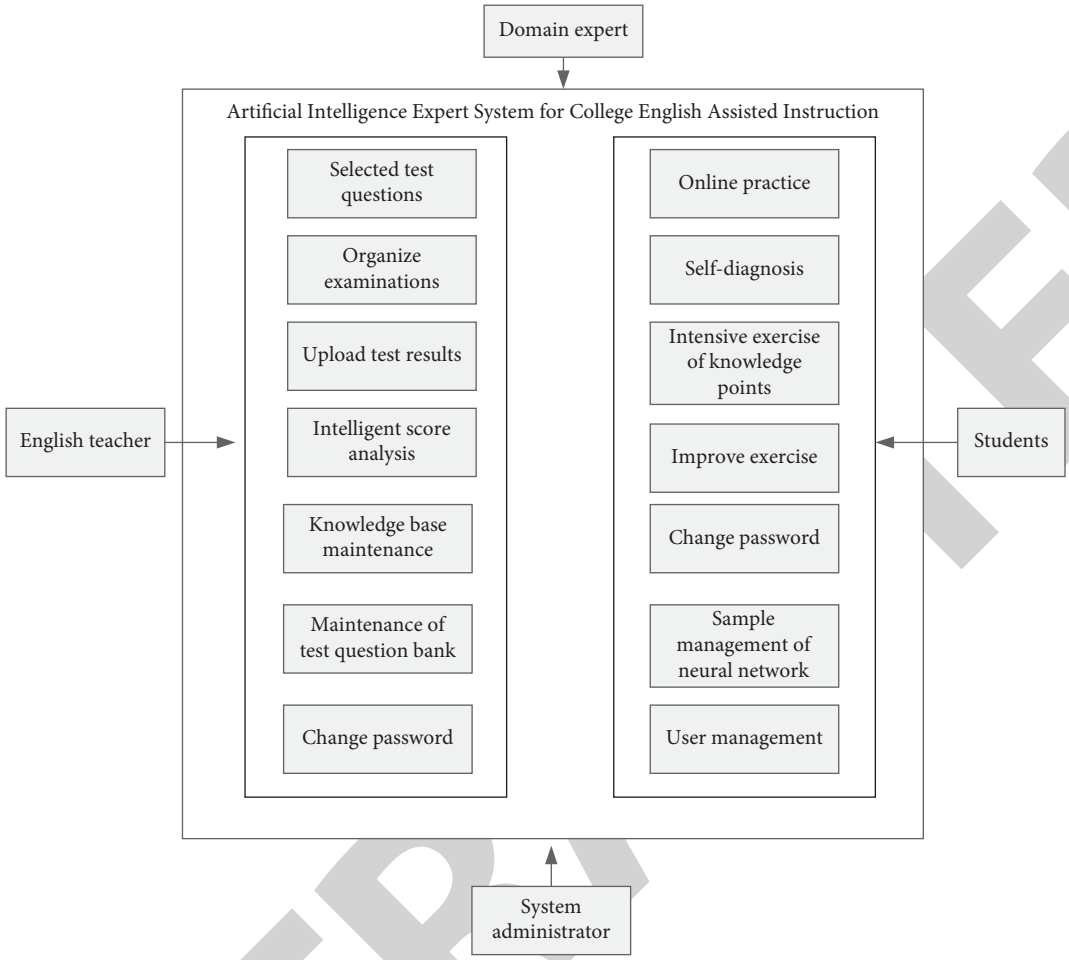

Figure 6: Overall structure of the system.

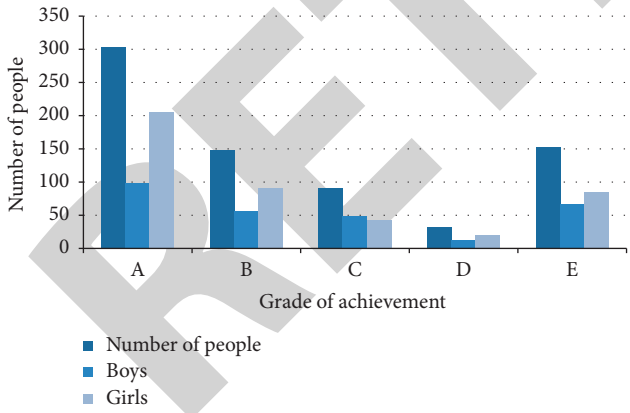

Figure 7: Distribution of male and female scores in five grades A-E.

Among them, the reasonable grasp of the test content in the English teacher system determines the trend of students' English scores, and the awareness of students' autonomous learning determines whether their English scores need to be improved. The system administrator has reasonable control over teachers, students, and domain experts and can control the trend of the question bank in time and notify the corresponding personnel to modify and perform other measures. Domain experts can analyze the vocabulary and knowledge points in English test questions, influence the educational content of English teachers, and put forward teaching experience.

4. An Experimental Analysis Based on College English Education

4.1. Analysis of Male and Female Distribution of Students' English Scores in A-E Grades in Decision Tree. From Figure 7, we can see the perspective of gender. The overall passing rate of female students is as high as 80.66%, while that of male students is only 76.33%, which shows that male students are inferior to female students in learning English.

4.2. Number of A-E Grades Given by Teachers in Decision-Making Method. The number of students who pass the English test in the class taught by different lecturers will have a fundamental influence on teachers' teaching content and teaching attitude, as shown in Figure 8.

After chart analysis, the pass rate of Lecturer 1 is 99%, Lecturer 2 is 87%, Lecturer 3 is 78%, Lecturer 4 is 92%, Lecturer 5 is 68% and Lecturer 6 is 59%.

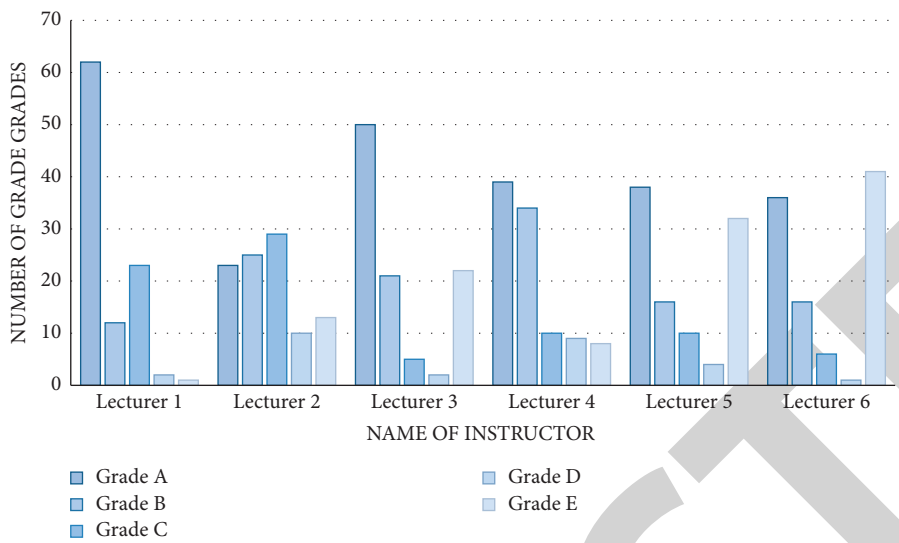

Figure 8: Distribution of A-E grades in classes taught by lecturers.

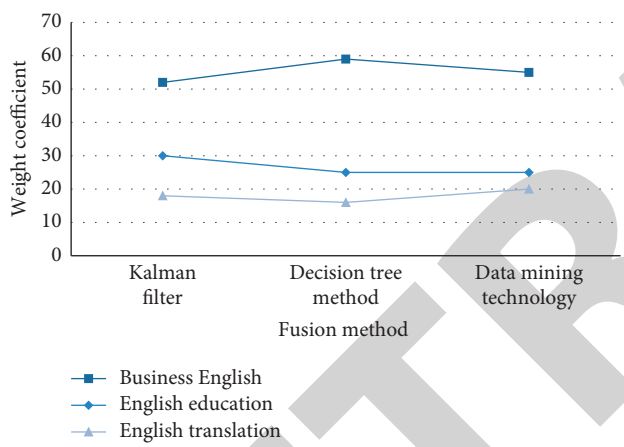

Figure 9: Weight ratio of various methods in different specialties.

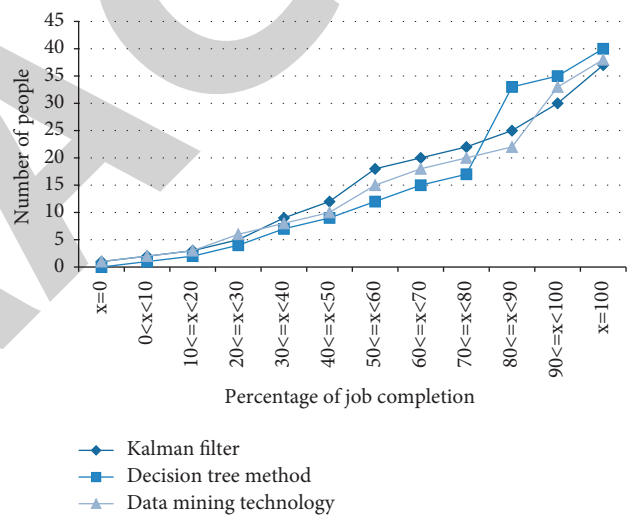

Figure 11: Percentage of job completion.

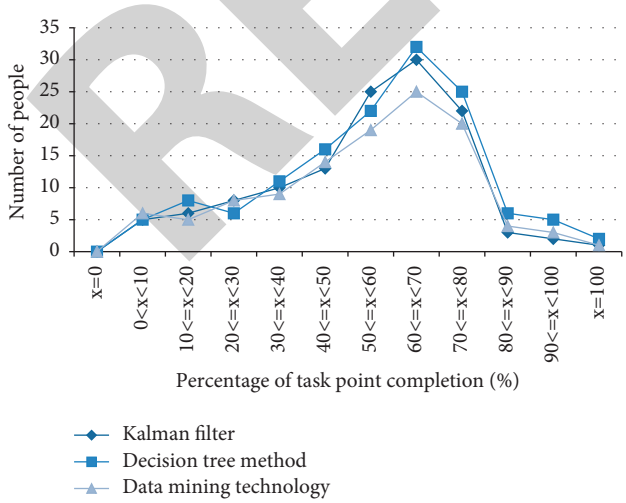

Figure 10: Percentage of task point completion.

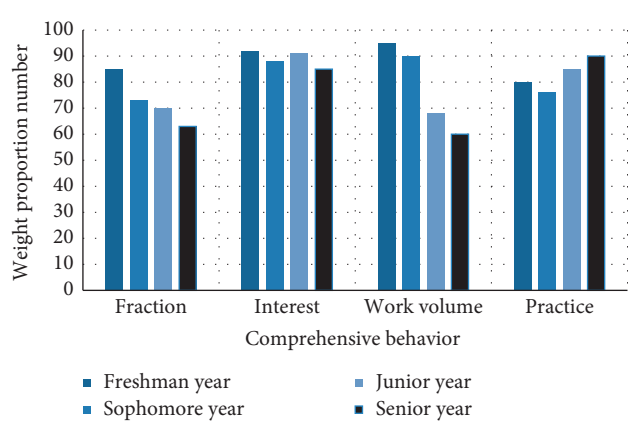

Figure 12: Weight ratio index chart of comprehensive analysis of English education from freshman to senior.

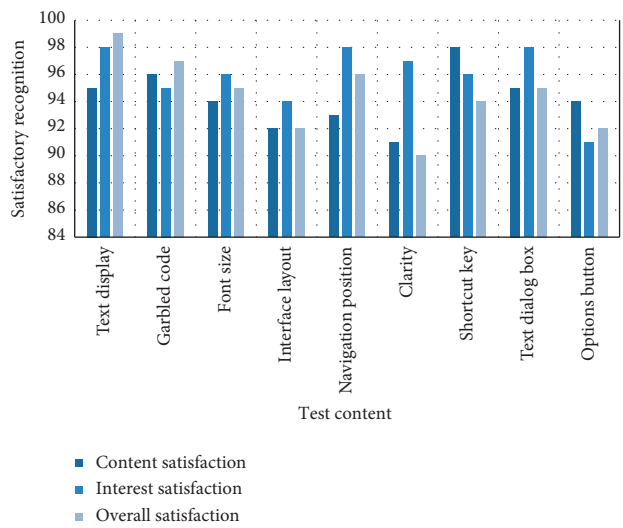

Figure 13: UI average satisfaction acceptance.

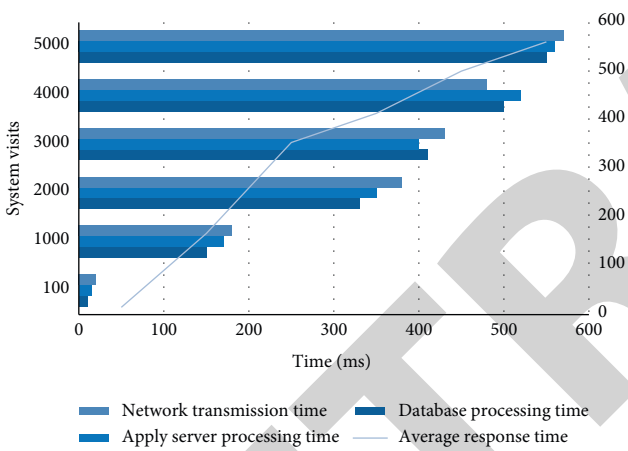

Figure 14: Response time distribution of original system.

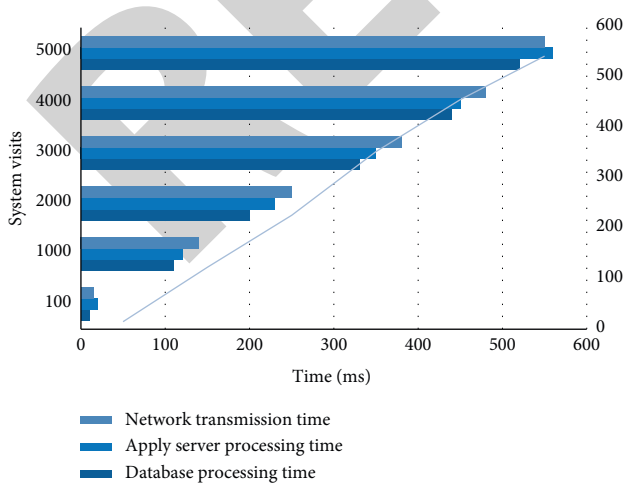

Figure 15: New system access response time.

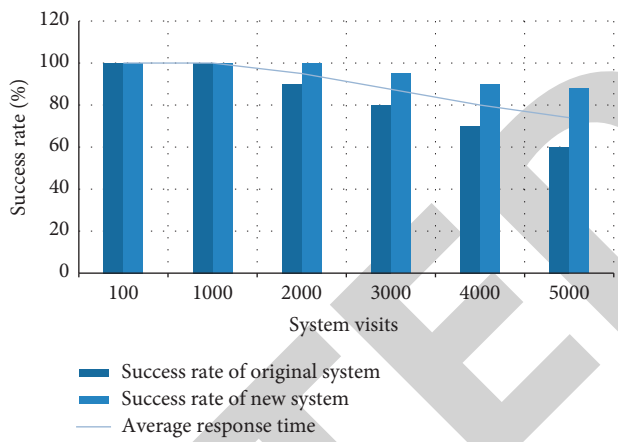

Figure 16: Comparative analysis chart of old and new systems.

4.3. Experimental Analysis of Information Technology Fusion. According to the different teaching methods adopted in English majors, the analysis of education level and the embodiment of teaching quality can be realized, as shown in Figure 9.

According to the data analysis, the decision tree method has the highest weight of 59% in business English under the analysis of the weight education results of different English majors. English education only occupies 25% of the weight in the decision tree method. In different English majors, different research methods have different educational purposes and different teaching effects.

4.4. Percentage of English Course Task Points and Assignments Completed. According to the task points assigned by teachers, the number of students who completed the tasks is investigated, and the influence of different methods on teaching quality is analyzed, as shown in Figure 10.

From the above chart, it can be seen that the task point percentage data of the three calculation methods are normally distributed. Among them, the percentage of students completing curriculum tasks is between 50% and 80%, most students have basically completed the study of curriculum tasks, and a few students have completed less than 40% of tasks. Percentage of job completion analysis is shown in Figure 11.

As can be seen from Figure 11, in the case of homework completion percentage, 115 people finished their homework 100%, but 2 people did not finish their homework at all. It greatly reflects the omission of teacher management.

According to the comprehensive analysis of different grades and behaviors, it shows that students' different adaptation and application of English education have different weight proportions, as shown in Figure 12.

It can be seen that from freshman to senior, students concentrate on their work and never pay attention to their studies. Their exam results will decline, and the corresponding homework will also decline. In social practice, senior students will have more opportunities to

communicate and work in English, but it will not be the promotion of interest that will increase the frequency of using English.

4.5. System Performance Test

4.5.1. Test Environment. The system test environment includes basic hardware and software testing.

Hardware environment: CPU, memory, hard disk, network card.

Software environment: operating system, running environment, and database.

Computers have different capabilities and software to run in environments where the quality of the hard disk meets the public's requirements for the basic performance of the computer, such as the display of text and other basic operating streams.

4.5.2. UI Testing. Although all the UI tests have passed in the user experience, there are great differences in different areas due to the strong autonomy of different students and teachers. There are also differences in satisfaction with different contents, among which the overall average satisfaction is 95%, while there are obvious differences in satisfaction with content and interest. The details are shown in Figure 13.

4.5.3. Response Time. It will be categorized according to the number of visits to the system, with six groups of 100, 1000, 2000, 3000, 4000, and 5000, and the response time of the original system and the new system will be compared. Through data analysis, we know that the response time of the new system is 57% lower than that of the original system, which is based on the fact that the response time of the original system is 161 ms while that of the new system is only 91 ms, which greatly reduces the working time and has a 100% success rate. The specific situation is shown in Figures 14–16.

5. Conclusion

In order to cultivate students' autonomous learning ability and teachers' teaching methods with different students' interests in learning English, great attention should be paid and effective changes should be made. At the same time, according to the changes of education system in the past decades, the importance of education development and the powerful information technology have greatly increased students' interest in education. It not only lightens the burden of teachers on teaching tasks but also promotes students' serious learning attitude towards English. In the face of the diversification of education industry and the substitution of teachers in the middle, students should strengthen their own exercise and rely on their solid basic skills to fully adapt to the variability of the environment. In order to strengthen the deep-rooted education in the student age, from grasping the details to analyzing and explaining all aspects is a good beginning of learning quality. Computer education in universities and English majors have achieved all-round coverage; in the future, it will make great contributions to the effective cultivation of education.

Further research work shall mainly focus on the integrated application and processing of English multi-platforms, for example, the collaborative translation of the results of translation system and big data mining system. Using big data mining technology to match the better translation results of application scenarios on the Internet can effectively improve the translation accuracy in different contexts.

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 author declares that there are no conflicts of interest.

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Retraction

Retracted: Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] S. Yun, Y. Bai, and B. Jongnam, "Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 6322570, 10 pages, 2022.

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Research Article

Quality Evaluation and Satisfaction Analysis of Online Learning of College Students Based on Artificial Intelligence

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In order to better study the quality and satisfaction of online learning of college students, this paper analyzes and researches online learning of college students based on relevant theories of artificial intelligence. Through the traditional machine learning method to evaluate the quality of online learning, the deep learning theory is applied to the satisfaction analysis of college students'' online learning. The results show that different statistical indexes have different influences on traditional machine learning, but they all show a gradually decreasing trend. The main reason for the different degrees of influence is that the emphasis of different statistical indexes is different, and the order from large to small is MAE > RMSE > MAPE > TIC. Statistical indicators can better describe the first stage of test data, while the corresponding quality indicators can better characterize the second stage of test data. It indicates that statistical and quality indexes should be considered comprehensively to analyze the test data accurately. The increase of evaluation indexes based on traditional machine learning can improve the evaluation indexes of online learning quality of college students. And the improvement of statistical indicators and evaluation factors can promote the accuracy of online learning quality evaluation of college students. Based on the theory of artificial intelligence, the quality and satisfaction of online learning of college students are analyzed and evaluated by using the traditional machine learning method and deep learning method, respectively. Relevant research can provide a research basis for artificial intelligence in online learning methods of college students.

1. Introduction

Artificial Intelligence (AI) has been widely applied in various fields: water turbine engine [1], optimization of high-rise buildings [2], renewable energy [3], immune analysis of smartphones [4], and automatic detection [5]. Artificial intelligence includes traditional machine learning and deep learning, and different contents have different application fields. In order to better analyze the data of images, the deep learning and the traditional machine learning algorithms used in image processing can be seen through the contrast analysis of the two algorithms. While deep learning under the theory of image processing precision is higher and has more obvious advantages, traditional machine learning has a good application in sample data [6].

Traditional machine learning has significant applications in biology, programming, etc. In order to promote the application of traditional machine learning algorithms in cell feature recognition, a comprehensive segmentation method based on traditional machine learning theory was proposed in [7]. This method avoids the relevant problems existing in the application process of traditional technology and can better carry out further slice analysis of cells. Moreover, the experimental verification shows that the time of the slice is greatly shortened, and the precision of the corresponding cell cutting technology is greatly improved. In view of a series of problems existing in deep learning methods in the process of gene coding, a kind of coding tool and model based on traditional machine learning algorithm was proposed in [8]. This model overcomes the shortcoming that the original model cannot reflect the internal structure of cells

well, and the model can be used to organize and replicate a large number of cells, and the replication results are highly consistent with the shape of the original sample. Finally, the accuracy of the model is verified by relevant experiments. In the process of online communication, we often encounter related problems such as slow language coding conversion speed, which will have a great impact on communication and work times. In order to further improve the speed of language conversion in communication engineering, a programming step based on a traditional machine learning algorithm is added on the basis of the original language conversion. By using the traditional machine learning algorithm, a large amount of data in the process of language communication can be classified and processed specifically. In this way, the speed of data extraction of each part is increased, and the grouping analysis algorithm is adopted to provide the targeted output of relevant languages. This step can be carried out before language communication, so as to greatly improve the speed of language conversion [9].

Deep learning has different application prospects in different fields. Artificial intelligence and theories related to deep learning are adopted to conduct targeted research on the learning framework and training methods of music. Through analysis, it is found that deep learning has a good application prospect in simulating music, and the use of deep learning algorithms can further improve the control and communication functions of music, and verify the accuracy of the model through practical tests [10]. In view of the problems existing in the process of facial expression recognition, a deep learning algorithm is proposed to improve the accuracy of facial recognition [11]. This model adopts the method of multi-angle analysis. The problems existing in traditional facial recognition are improved so that the optimized deep learning algorithm can adapt to face recognition in a complex environment. Firstly, the optimized algorithm is used to accurately identify the face. At this stage, accurate recognition of the face can improve the efficiency of the next step of the analysis. The optimized extraction algorithm can make the recognition and extraction of facial parameters more targeted. By inputting relevant keyword parameters, the targeted recognition data can be obtained. In this way, the identification accuracy can be improved and the interference of useless data can be reduced. The facial recognition data obtained by the optimization algorithm are imported into machine learning. Through the further calculation of machine learning, the derived data can more accurately reflect the facial features of each sample. So as to better apply the data analysis method, experimental verification is an important step to test samples. By using 300 samples to test the optimization scheme, the results show that the accuracy of the optimization scheme is about 20% higher than the original method. Demonstrate the reliability of machine learning methods. In order to further improve the application of deep learning in medical diagnosis, a new research method based on deep learning theory was proposed in [12]. The method realizes the diagnosis and analysis of the lesion site through the diagnosis, analysis, and treatment of the lesion site, and then realizes the application of deep learning in the medical field. In order to further verify the diagnostic accuracy of the model, laboratory experiments are used to illustrate the superiority of deep learning. Deep learning can also be used to describe the folding and separation of proteins [13]. The quantitative characterization and description of proteins can be achieved by using an accurate deep learning model, providing a new research direction for the model. In view of the existing problems in the field of the lithium battery, the deep learning method was adopted to construct relevant models [14], so as to obtain different types of targeted analysis methods. The optimization model imports the relevant data of the lithium battery into the corresponding learning algorithm. Through the analysis and extraction of the algorithm, the feature vector and feature parameter relationships of the lithium battery under the algorithm are found. Then, feature vectors and curves corresponding to feature relations are put into the analysis plate. The corresponding relationship between the characteristic vector and characteristic parameter curve of a lithium battery can be studied in this plate, and the quantitative relationship between them can be found. The characteristic parameter curves are used to characterize feature vectors so that the two factors are transformed into one factor. The analysis plate can greatly compress the calculation data of the lithium battery, so as to greatly reduce the calculation time and improve the calculation speed in the process of data export. Finally, this method is used to verify the model.

The abovementioned research is mainly based on the relevant theories of artificial intelligence and adopts the traditional machine learning and deep learning algorithms to apply biology, information recognition, and other aspects. In order to further promote the application of artificial intelligence in online learning of college students. This paper evaluates the online learning quality of college students based on the evaluation model of traditional machine learning theory and combined with the theory of artificial intelligence. Based on deep learning algorithm, the satisfaction degree of online learning of college students is analyzed. Finally, the accuracy of relevant indicators is verified by two experiments. This study can provide theoretical support for AI in the online learning of college students and other aspects.

2. The Basic Theory of Traditional Machine Learning

2.1. Prediction Module Design. Machine learning is an interdisciplinary subject and the core of artificial intelligence. It covers multidisciplinary theoretical knowledge such as statistics and methodology. By using computer-aided tools in the context of big data to target and simulate behaviors and methods related to human activities. The performance of relevant models is optimized by theoretical analysis and experimental verification. With the advent of the era of big data, more and more data analysis methods and means are applied to model construction and data analysis. Machine learning can effectively extract knowledge from data and provide technical support for the industry. This has created unprecedented opportunities for the development of

machine learning. Machine learning has superior performance in regression tasks and is considered as a favorable tool for studying online learning and the education of college students because of its better accuracy and pertinence.

Whale Optimization Algorithm (WOA) is a typical traditional machine learning algorithm [15]. The whale optimization algorithm simulates the hunting behavior of humpback whales, which consists of searching for prey, surrounding prey, and "bubble net" foraging. Tests on mathematical optimization and structural engineering problems show that the whale optimization algorithm has an excellent performance in exploration, utilization, avoiding local optimization, and convergence [16]. The analysis mechanism of WOA is shown in Figure 1, and the corresponding mathematical model can be divided into the following aspects:

2.1.1. Data Collection. WOA first defines the optimal algorithm for relevant data, and then approaches the search operation process of other data toward the optimal one, so as to update the data. The relevant formula is as follows:

$$\begin{cases} \vec{D} = \left[\vec{C} \times \vec{X}^*(t) - \vec{X}(t)\right], \\ \vec{X}(t+1) = \vec{X}^*(t) - \vec{A} \times \vec{D}, \end{cases} \tag{1}$$

where t is the current iteration; $\vec{X}^*$ is the position vector; $\vec{X}$ is the position vector; $\vec{A}$ and $\vec{C}$ are coefficient vectors.

$$\begin{cases} \vec{A} = 2\vec{a} \times \vec{r} - \vec{a}, \\ \vec{C} = 2\vec{r}, \end{cases} \tag{2}$$

where $\vec{r}$ is the random vecto and $\vec{a}$ decreases linearly from 2 to 0 during iteration.

2.1.2. Data Calculation. The $\vec{a}$ value in formula (2) is used to realize data calculation, and the fluctuation range $\vec{A}$ is reduced accordingly.

The corresponding positions of the data can be analyzed by establishing the helix equation:

$$\begin{cases} \vec{X}(t+1) = \vec{D}^* \times e^{bl} \times \cos(2\pi l) + \vec{X}^*(t), \\ \vec{D}^* = \left|\vec{X}^*(t) - \vec{X}(t)\right|, \end{cases} \tag{3}$$

where $\vec{D}^*$ is the distance from the i-th data to the optimal solution; b is the constant of the logarithmic spiral shape; l is a random number in [−1, 1].

$$\vec{X}(t+1) = \begin{cases} \vec{X}^*(t) - \vec{D} \times \vec{A}, & \text{if } p < 0.5, \\ \vec{D}^* \times e^{bl} \times \cos(2\pi l) + \vec{X}^*(t), & \text{if } p \geq 0.5, \end{cases} \tag{4}$$

where p is a random number in [0, 1].

2.1.3. Data Analysis. When $\vec{A}$ greater than 1 or less than −1, the data search process will be far away from the optimal value. The analysis method of artificial intelligence can highlight the process of exploration and enable the WOA algorithm to conduct a global search. The corresponding mathematical model is as follows:

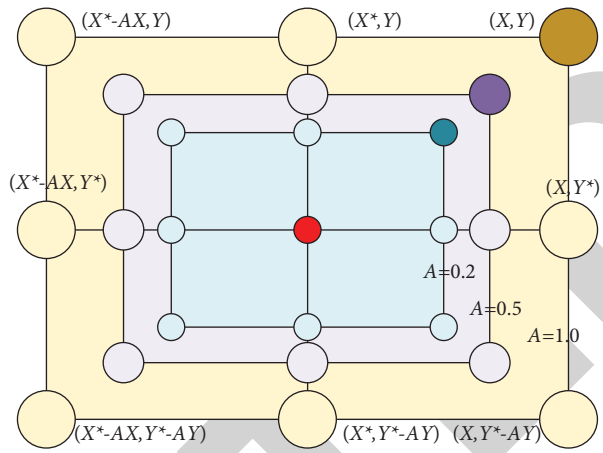

Figure 1: WOA computer graphics.

$$\begin{cases} \vec{D} = \left|\vec{C} \times \vec{X}_{\text{rand}} - \vec{X}\right| \\ \vec{X}(t+1) = \vec{X}_{\text{rand}} - \vec{A} \times \vec{D}, \end{cases} \tag{5}$$

where $\vec{X}_{\text{rand}}$ is the vector.

The whale optimization algorithm starts its calculation with a set of random solutions. During each iteration, the search agent updates its position based on the randomly selected search agent or the currently obtained optimal solution. When parameter a decreases from 2 to 0, exploration and utilization can be guaranteed. When $\vec{A}$ is greater than, a random search agent can be selected. The optimal solution is chosen when $\vec{A}$ is less than 1. According to the change of p value, the whale optimization algorithm can switch between spiral and circular movement. When the termination condition is met, the iteration stops. The WOA algorithm has a relatively low computational speed during calculation. In order to further improve the computational speed of this algorithm, relevant theories of extreme learning machine are introduced into the WOA algorithm [17], so as to obtain extreme learning machine (ELM). ELM has good generalization ability, and its learning speed is thousands of times faster than mainstream models [18] (Figure 2). The network structure diagram of an extreme learning machine can be divided into the input hiding layer and output layer according to the different analysis functions. The data are first imported into the input layer, through which the data are analyzed and processed, and then the analyzed data are imported into the hidden layer. Then through the relevant algorithms of the hidden layer to modify the data, and then the modified data are imported into the output layer for further optimization, and finally, the corresponding data are exported.

ELM can randomly generate independent samples w and b before training, and the hidden neuron threshold β can be calculated by determining L and H [19]. To further analyze the influence of parameters on ELM, the weight proportion

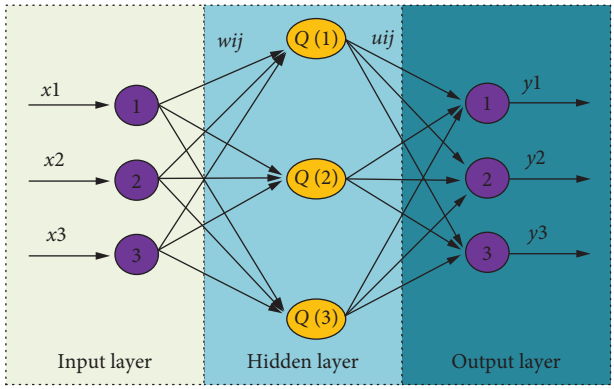

Figure 2: The network structure diagram of the extreme learning machine.

curves under different parameters were drawn, as shown in Figure 3.

According to the weight proportion of different parameters in the ELM algorithm, different parameters have different impacts on ELM. Among them, parameter w has the greatest influence, which accounts for about 1/3 of the weight of ELM on the whole. The performance is first gentle and then gradually declines, and finally gradually rises and tends to a steady increase in the changing trend. Secondly, parameter b is next to parameter w in weight proportion. The overall variation trend of parameter b is basically consistent with parameter w, accounting for about 1/5 of the weight of ELM. The weight of parameter H was the lowest, and the weight of parameter L was slightly higher than that of parameter H. Therefore, the weight of different parameters on ELM was in the following order: $w > b > L > H$.

2.2. Evaluation Module Design for Traditional Machine Learning. To evaluate the prediction performance of the ELM model, different statistical indicators were used to analyze the model [20]: aiming at the application of traditional machine learning in online learning of college students, in order to better analyze the quality of online learning of college students, different indicators are used to evaluate traditional machine learning. The specific meanings of different indicators are shown as follows: MAE can accurately reflect the size of prediction error. RMSE is similar to MAE but more sensitive to outliers. MAPE can reflect the deviation of forecast values. TIC is a common indicator to measure the prediction ability of the model, while r can reflect whether the model can accurately predict the changing trend of pollution.

Mean Absolute Error (MAE) is as follows:

$$\mathrm{MAE} = \frac{1}{N}\sum_{i=1}^{N}\left|F_i - Q_i\right|. \tag{6}$$

Root Mean Square Error (RMSE) is as follows:

$$\mathrm{RMSE} = \sqrt{\frac{1}{N}\sum_{i=1}^{N}\left(F_i - Q_i\right)^2}. \tag{7}$$

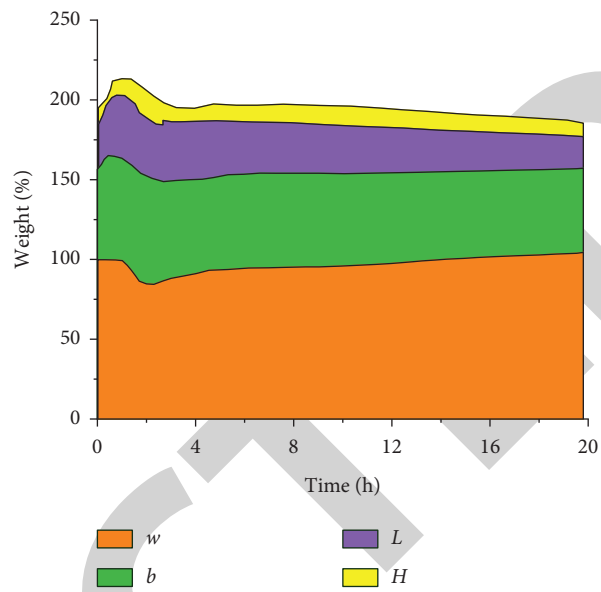

Figure 3: The weight diagram of different parameters on ELM.

Mean Absolute Percentage Error (MAPE) is as follows:

$$\mathrm{MAPE} = \frac{1}{N}\sum_{i=1}^{N}\left|\frac{F_i - Q_i}{Q_i}\right|. \tag{8}$$

Theil Inequality Coefficient (TIC):

$$\mathrm{TIC} = \frac{\sqrt{(1/N)\sum_{i=1}^{N}\left(F_i - Q_i\right)^2}}{\sqrt{(1/N)\sum_{i=1}^{N}F_i^2} + \sqrt{(1/N)\sum_{i=1}^{N}Q_i^2}}. \tag{9}$$

Correlation coefficient r is as follows:

$$r = \frac{\sum_{i=1}^{N}\left(F_i - \overline{F}\right)\left(Q_i - \overline{Q}\right)}{\sqrt{(1/N)\sum_{i=1}^{N}\left(F_i - \overline{F}\right)^2} + \sqrt{(1/N)\sum_{i=1}^{N}\left(Q_i - \overline{Q}\right)^2}}. \tag{10}$$

where N is the number of samples. F_i and Q_i are the forecast value and actual value of the i-th sample, respectively. $\overline{F}$ and $\overline{Q}$ are the average of the forecast value and the actual value, respectively.

To further analyze the influence of the abovementioned parameters on the model, change curves of the model under different parameters were drawn, as shown in Figures 4 and 5, respectively. It can be seen from Figure 4 that different parameters have different specific values of change, but the overall trend of change is gradually decreasing, indicating that with the increase of iteration times, the influence degree of corresponding parameters is gradually decreasing. The reason is that the parameters of the model are further modified and optimized by the traditional machine learning algorithm, which leads to the gradual decline of corresponding parameters. Specifically, it can be concluded that the value of parameter MAE is the largest, and that of parameter RMSE is second only to that of parameter MAE. The influence degree of parameter MAPE is higher than that of parameter TIC, and the influence degree of parameter TIC is the least.

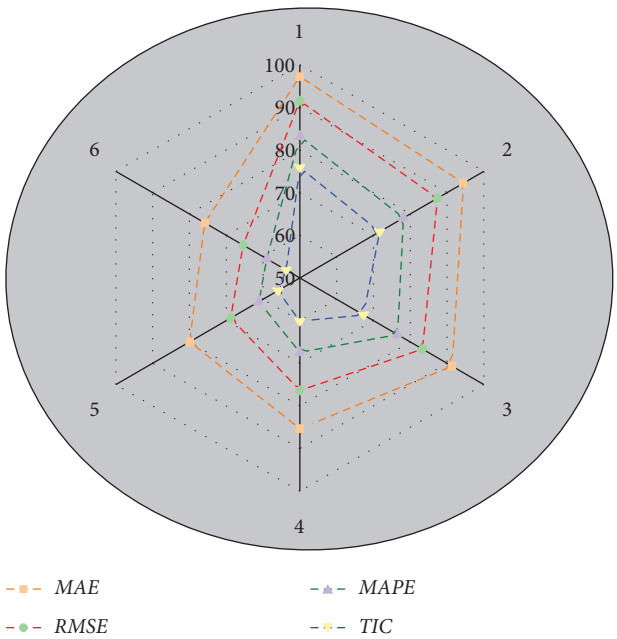

Figure 4: The variation trends of different parameters.

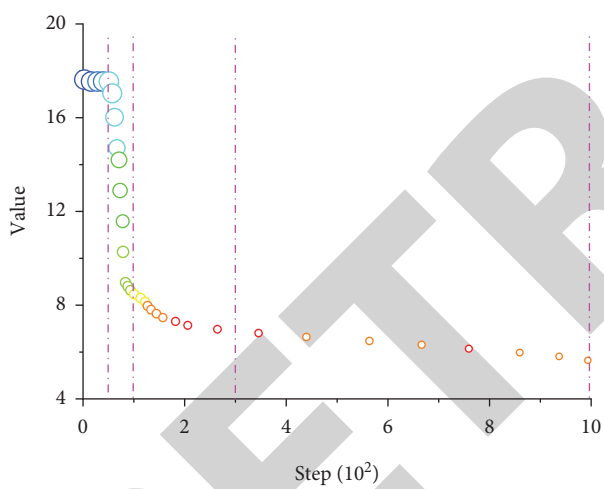

Figure 5: The variation trend of correlation coefficient r.

The change curve of correlation coefficient r is shown in Figure 5, from which we can see that this parameter shows a fluctuating trend. On the whole, it can be divided into four stages according to the trend of change. (1) In the stable stage, the influence value of correlation coefficient R shows a gentle change trend in this stage, indicating that the influence degree of correlation coefficient in this stage remains unchanged. (2) In the drop stage, the curve suddenly drops as the number of iterations increases. The main reason for the sudden drop in the curve is the difference in model data. After the rapid decline of the second stage, the curve suddenly drops. (3) In the flat stage, the change curve of correlation coefficient R enters the third stage, during which the data of correlation coefficient gradually decreases, and the slope of corresponding data shows a trend of zero. (4) In the stable stage, at last, with the increase of the number of iterations, the change of the data tends to be gentle and finally stable, indicating that the data has reached a stable degree, and also indicating that the calculation results of the corresponding traditional machine learning model tend to be stable.

The abovementioned analysis enables us to have a deep understanding of the basic theory of traditional machine learning. In order to further improve the evaluation accuracy of online learning quality of college students, a machine learning algorithm is introduced to build the corresponding model architecture, as shown in Figure 6. The component diagram of the online learning quality evaluation model of college students under machine learning can be divided into three modules, namely, preprocessing module, analysis module, and evaluation module. The preprocessing module mainly includes data insertion and supplements. In this stage, the data can be further analyzed and processed to make the obtained data have better extraction characteristics. Then the data are imported into the analysis module, which mainly includes signal analysis and network optimization. The data are imported into the neural network. After the analysis through the neural network, the data are imported into the estimation module, and further statistical analysis and evaluation of the data in the module are carried out through the five different parameters mentioned above. Finally, the obtained data are exported from the model architecture diagram.

3. Related Theories of Deep Learning

3.1. Design of Prediction Model Based on Deep Learning Theory. Convolutional Neural Networks (CNN) are feedforward Neural Networks containing Convolutional operations and deep structures and are classic deep learning algorithms [21] (Figure 7). A convolutional neural network mimics the construction of a biological visual perception mechanism, which can carry out supervised and unsupervised learning. The parameter sharing of a convolutional kernel in the hidden layer and the sparsity of interlayer connections enable the convolutional neural network to dot lattice features with a small amount of computation. The evaluation and analysis of the online learning quality of college students have a stable effect and no additional feature engineering requirements for data. The corresponding calculation formula is as follows:

$$\begin{cases} Z^{l+1}(i,j) = \left[Z^{l} \otimes w^{l+1}(i,j)\right] + b \\ L_{l+1} = \dfrac{L_l + 2p - f}{s_0} + 1, \end{cases} \tag{11}$$

where Z^l and Z^{l+1} are the input and output of convolution at layer $l+1$; L_{l+1} is the size of Z_{l+1}; b is the number of convolution layers; p is the number of filling layers; f is the activation function in the convolutional layer.

$$A^{l}_{i,j,k} = f\left(Z^{l}_{i,j,k}\right), \tag{12}$$

where f is the convolution layer. The parameters of the convolutional layer include the size, step size and fill of the

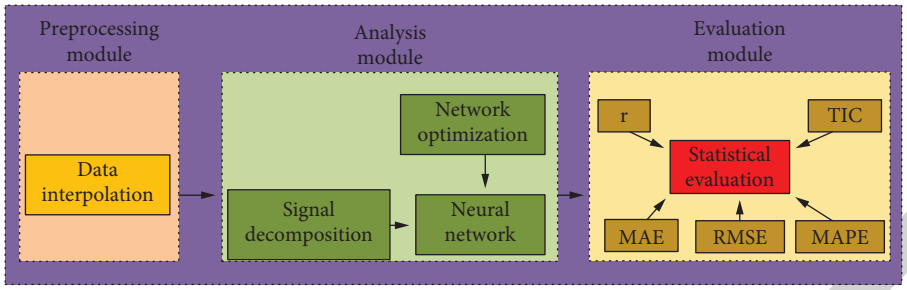

Figure 6: The structure diagram of the online quality evaluation model for college students under machine learning.

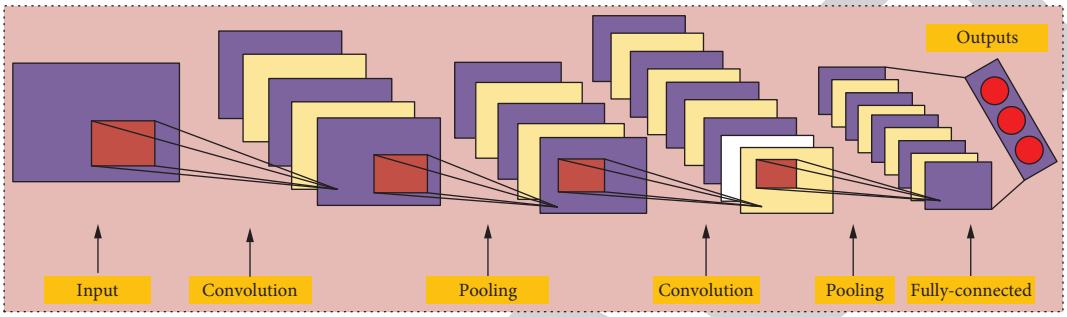

Figure 7: The model architecture diagram of Convolutional Neural Network (CNN).

convolution kernel, which jointly determines the size of the output feature graph of the convolutional layer and are the hyperparameters of the convolutional neural network. The size of the convolution kernel can be specified as any value smaller than the size of the input image. The larger the convolution kernel is, the more complex the input features can be extracted. By analyzing and extracting characteristic parameters of college students' online learning, the relevant parameters of the convolutional neural network are used to optimize online learning, so as to obtain accurate calculation results.

$$A_k^l(i,j) = \left[\sum_{x=1}^{f}\sum_{y=1}^{f} A_k^l(s_0 i + x, s_0 j + y)^p\right]^{1/p}, \tag{13}$$

where p is the preset parameter, and s_0 is the convolution step.

Hidden layers of convolutional neural networks include three common constructs: convolutional layer, pooling layer, and full connection layer. Some more modern algorithms may have complex constructs such as the Inception module and residual block. Among the common architectures, the convolutional layer and pooling layer are special to the convolutional neural network. The convolution kernel in the convolution layer contains weight coefficients, while the pooling layer does not. An implicit layer of a convolutional neural network can be used to evaluate and analyze college students' online learning.

It can be seen from the abovementioned analysis that the preset parameters have a certain influence on the activation function in the model. To analyze the impact of the preset parameters on the model results in detail, the model data output curves under different preset parameters are drawn, as shown in Figure 8. Through the influence curve of the

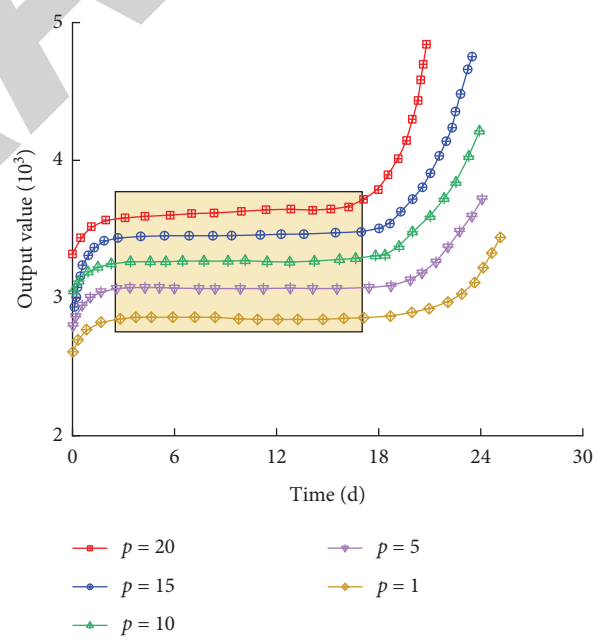

Figure 8: The influence of preset parameter p on the prediction model.

preset parameter P on the prediction model, we can see that different preset parameters will have a great impact on the operation results of the model. Corresponding curve changes can be divided into three stages. The first stage is the stage of slow increase, in which the output value of the corresponding model parameters shows a trend of gradual increase, but the slope of the corresponding curve gradually decreases and eventually approaches zero. Thus, model parameters enter the second stage. In the stable increase

stage, the output value of model parameters tends to be stable, and the corresponding curve slope tends to zero. After a long period of stability, the model enters the third stage. In the acceleration stage, the data of the curve shows a rapidly increasing trend. It indicates that the longer the model runs, the greater the influence on the output value of model parameters. It can be seen from the size of different preset parameters P that, with the gradual increase of preset parameters. The output value of the corresponding model shows a trend of rapid increase, indicating that the larger the preset parameter value is, the greater the influence on model parameters is.

3.2. Evaluation Model Based on Deep Learning. Model evaluation indexes based on deep learning mainly include statistical indexes and quality indexes [22]:

(1) *Statistical Indicators*. Normalized Mean Bias (NMB) is as follows:

$$\mathrm{NMB} = \frac{\sum_{i=1}^{N}(F_i - Q_i)}{\sum_{i=1}^{N} Q_i}. \tag{14}$$

(2) *Quality Index (QI)*. The calculation formula for analysis accuracy of the QI Index is as follows:

$$\mathrm{QI} = \frac{n_{\mathrm{QI}}}{N_{\mathrm{QI}}}, \tag{15}$$

where QI is the analysis accuracy rate; n_{QI} is the number of samples for analyzing accurate indicators; and N_{QI} is the total number of samples.

Figure 9 shows the evaluation and analysis curves of the model under two different indicators. It can be seen from the evaluation and analysis diagrams of the model under different indicators that the statistical indicators and quality indicators are typically segmented. In the first stage, the statistical indicators show typical linear characteristics, and the corresponding curve slope is approximately constant. When falling to the second stage, the curve shows a nonlinear downward trend. The corresponding slope shows a rapid decline at first and then tends to gentle change, which also indicates that the corresponding statistical index value will gradually tend to be stable. The changing trend of the corresponding quality index was opposite to that of the statistical index. The quality index increased slowly in the first stage and then rapidly tended to the maximum value. The slope of the corresponding curve increased slowly at first and then rapidly. When the curve enters the second stage, it shows a relatively gentle decline and the corresponding slope is basically stable, indicating that the corresponding data curve shows an approximately linear trend of change. It can be seen from the test data that the test data showed obvious linear characteristics in both stages, showing a linear increase in the first stage and a linear decline in the second stage. In addition, the slope of the curve in the first stage is larger than that in the second stage, indicating that neither a single statistical index nor a

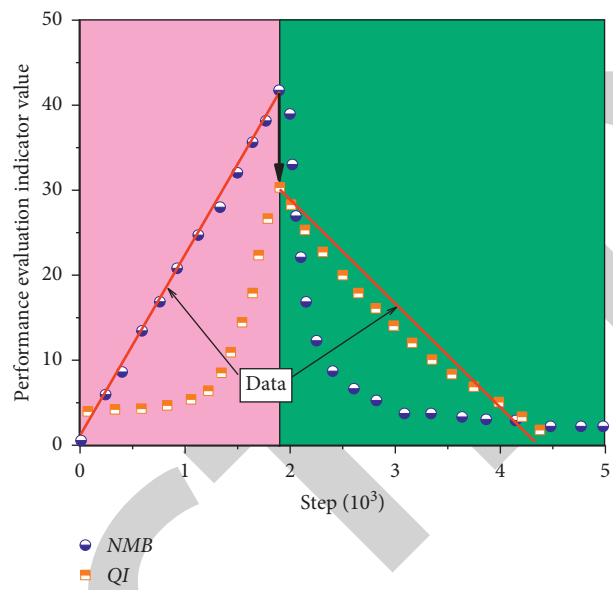

Figure 9: The analysis diagram of model evaluation with different indicators.

quality index can better reflect the changing trend of data. Therefore, the experimental data can be described and analyzed by combining the statistical index and quality index.

Through the abovementioned analysis of relevant theories under deep learning, the design and analysis of model architecture under deep learning can be obtained, as shown in Figure 10. Through the model architecture diagram of deep learning, we can see that the model architecture can be divided into three parts: data preprocessing module, feature module selection, and feature module construction. Among them, the data processing module is mainly to import the data into the corresponding module and normalize the data. Secondly, the data are imported into the feature module, and the effective feature parameters are obtained through feature analysis and extraction of the data. Finally, the extracted parameters are imported into the feature building module, and the corresponding learning module is finally obtained through the decomposition of the feature combination. Through the learning module, the parameters of the model can be further processed, and finally, the corresponding satisfaction evaluation model under deep learning can be obtained.

4. Application of Artificial Intelligence in Online Learning of College Students

Contemporary college students spend more and more time on online learning, so different models are needed to evaluate and analyze learning quality and satisfaction [23]. AI has a wide range of applications in various aspects, among which traditional machine learning theory and deep learning as the two most typical artificial intelligence that can be used in learning evaluation. The relevant theories of traditional machine learning can be used to evaluate the quality of online learning of college students, and the relevant theories

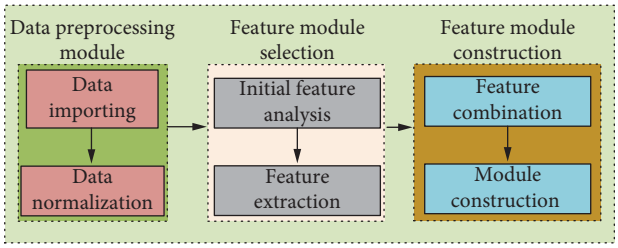

Figure 10: The model architecture diagram based on deep learning.

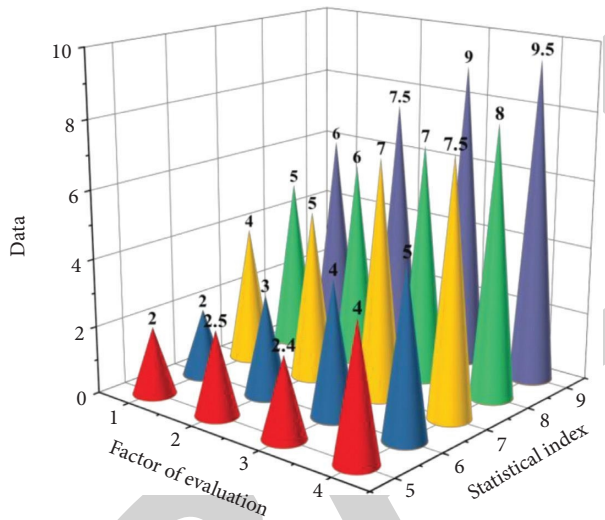

Figure 11: The quality evaluation diagram of statistical indexes under different evaluation factors.

of deep learning can be used to analyze the satisfaction of online learning of college students.

4.1. Evaluation of Online Learning Quality of College Students Based on Traditional Machine Learning. The evaluation of the online learning quality of college students can be mainly divided into four aspects: pre-class preview, classroom performance, homework, and examination [24]. Based on the relevant theories of traditional machine learning, the evaluation of online learning quality of college students can be realized through the design of corresponding evaluation modules, and statistical data curves under different evaluation factors can be obtained, as shown in Figure 11. The corresponding data are shown in Table 1. Among them, 1–4, respectively, represent pre-class preview, class performance, homework, and exam, and 5–9, respectively, represent MAE, RMSE, MAPE, and TIC. According to the quality evaluation change data of statistical indicators under different evaluation factors, it can be seen that with the gradual improvement of evaluation factors, the corresponding statistical quality indicators show a gradually increasing trend. It shows that the improvement of the evaluation index can improve the evaluation quality index. It can be seen from statistical indicators that different statistical indicators have different quality evaluation results. With the increase of statistical indexes, the corresponding quality indexes also show an increasing trend, indicating that the higher the evaluation index factors and statistical indexes are, the higher the corresponding data output value will be. It shows that the quality of online learning and quality evaluation of college students are higher.

4.2. Analysis of College Students' Learning Satisfaction Based on Deep Learning. In order to better analyze the satisfaction of online learning of college students under deep learning, the evaluation model of deep learning is used to analyze the corresponding satisfaction indicators, which mainly include knowledge application, memorized knowledge, proficiency, energy investment, and classroom perception [25]. Statistical data of college students' satisfaction with online learning under different factors are obtained through analysis, as shown in Table 2, and corresponding change curves are drawn, as shown in Figure 12.

Through the satisfaction analysis chart of statistical indicators under different evaluation factors, we can see that different factors have different influences on the satisfaction of specific indicators. Among them, according to NMB factor analysis, memorizing knowledge is the most important factor affecting satisfaction, followed by proficiency, classroom perception, energy investment, and knowledge application. However, QI analysis factors are different from NMB, in which knowledge application is the most influential factor in satisfaction, followed by proficiency, classroom perception, energy involvement, and memory knowledge. It

Table 1: The quality evaluation table under different factors.

Number	Factor	Statistical index	Data	Number	Factor	Statistical index	Data
1		MAE	2	11		MAE	2.4
2		RMSE	2	12		RMSE	4
3	Preclass preview	MAPE	4	13	Homework	MAPE	7
4		TIC	5	14		TIC	7
5		r	6	15		r	9
6		MAE	2.5	16		MAE	4
7		RMSE	3	17		RMSE	5
8	Classroom performance	MAPE	5	18	Examination	MAPE	7.5
9		TIC	6	19		TIC	8
10		r	7.5	20		r	9.5

Table 2: statistical table of satisfaction under different factors.

Number	Factor	Analysis index	Data
1		Knowledge application	0.787
2		Memory of knowledge	0.952
3	NMB	Proficiency	0.869
4		Energy input	0.8
5		Class awareness	0.846
6		Knowledge application	0.825
7		Memory of knowledge	0.628
8	QI	Proficiency	0.769
9		Energy input	0.682
10		Class awareness	0.751

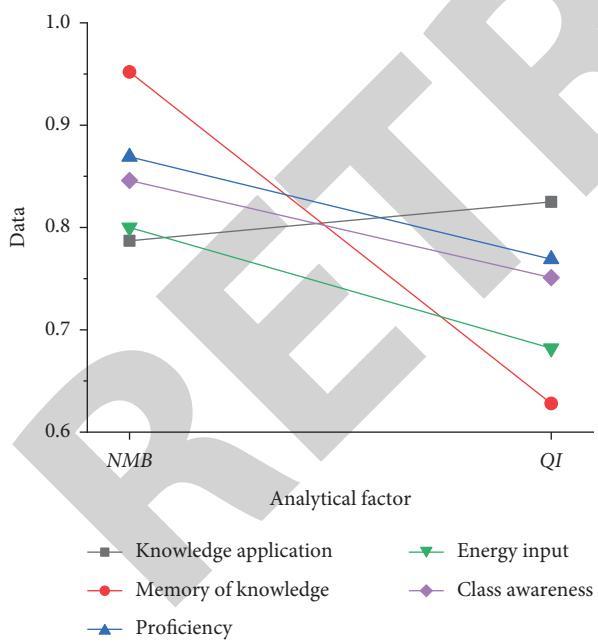

Figure 12: The satisfaction analysis of statistical indexes under different evaluation factors.

indicates that the satisfaction of NMB and QI is different from that of statistical indicators. Therefore, it is necessary to comprehensively consider the two factors to obtain the correct results for the online learning satisfaction analysis of college students.

5. Conclusion

(1) The correlation coefficient r can be divided into the stable stage, falling stage, gentle stage, and stable stage according to the changing trend. The large variation range of this parameter indicates that it has a great influence on the evaluation module in traditional machine learning.

(2) According to the weight proportion diagram of different parameters in the ELM algorithm, it can be seen that different parameters have different impacts on ELM. The main reason is that the difference in independent samples will lead to the difference in the training random generation process, and the weight function of the input layer and the hidden layer will change. As a result, the output matrix is different, and finally, the weight ratio of parameters to ELM is different. The proportion of parameter w is the largest, and that of parameter H is the smallest.

(3) The influence curve of the preset parameter p on the forecast model can be divided into three stages according to the variation trend and model rule: slow increase stage, steady increase stage, and acceleration stage. And the gradual increase of preset parameter p will lead to the rapid increase of the corresponding model.

(4) According to the satisfaction survey results of college students based on deep learning, the influence degree of knowledge memorization is the highest under the NMB parameter, while the influence degree of

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Retraction

Retracted: Blockchain-Based Intelligent Interconnection System Optimization Decision

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] C. Wang, S. Hao, and Y. Ma, "Blockchain-Based Intelligent Interconnection System Optimization Decision," *Security and Communication Networks*, vol. 2022, Article ID 6818562, 12 pages, 2022.

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Research Article

Blockchain-Based Intelligent Interconnection System Optimization Decision

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This article conducts a comprehensive analysis of the relevant content of blockchain; blockchain is a new field that has only emerged in recent decades, and it has a high level of new energy that cannot be compared with other fields. This article proposes the advantages and disadvantages of blockchain and the current factors that trigger network security defense. A multimicrogrid customer transaction system under the blockchain technology is also proposed. We will illustrate the compatibility between multimicrogrid and blockchain, which is self-adaptive and can be adjusted in time with market changes. Third, in order to ensure the normal operation of the distribution network, a smart contract dynamic constraint scheme is designed for power flow constraints and voltage offset problems. Multimicrogrid system as energy interconnection research on multiagent competitive game on multimicrogrid system is crucial to the development of energy Internet technology. Blockchain-based decision-making systems exist based on a comprehensive analysis of the needs and interests of microgrid operators, large users, and distributed aggregators. For the complex problem of multimicrogrid system competition game model, a suitable solution method (IACO) is proposed. The model and solution algorithm established by the experiment are accurately analyzed, and the simulation result is that the optimal electricity price strategy in the subdivision field can effectively balance the interests of different market players and achieve win-win and coordinated development. Experiments show that IACO can deal with the multiple problems of blockchain.

1. Introduction

In view of the defects of the existing blockchain system, this paper proposes Hawk, a brand-new decentralized blockchain, which perfectly solves the problem of exposing the privacy of customers to the blockchain. The compiler it uses zero-knowledge proof, etc. The cryptographic primitives are written into an efficient cryptographic protocol between the contracting party and the blockchain, thus ensuring its security [1]. Through the comparison and combination of blockchain and the Internet, this paper analyzes several advantages and concludes that if applicable, the integration of blockchain and the Internet will definitely cause a historic change in the industry, which will lead to more uncertain roads in the future [2]. The performance problems of the early Bitcoin POW blockchain are no longer meaningful today, so this paper makes a simple comparison between POW blockchain and BFT blockchain, and studies how to improve the scalability limit problem, and also provides a comprehensive understanding of "The ultimate" blockchain structure is outlined [3]. This paper proposes a basic model of the blockchain system, discusses the principle, technology, method and application of the blockchain, and the related Bitcoin system. We also discuss smart contracts and their applications, and propose future trends in a blockchain-enabled parallel society. This paper mainly provides some reliable data for future work [4]. This paper addresses the innovative impact of blockchain's verification and network costs on shaping digital platforms, where shared data supports multiple intellectual property rights and allows participants to coinvest without assigning market power to platform operators. They also challenge existing revenue models and present opportunities for new approaches to data ownership and licensing [5]. In this paper, 3G technology and GpsOne technology are combined in the Intelligent Transportation System (ITS), the principle is described, and the working principle and hardware structure of the intelligent vehicle navigation and wireless

interconnection system are discussed [6]. The Internet of Things intelligence in the field of power system can play the role of early warning and protection through computers, remote monitoring, etc. [7]. In this paper, the intelligent high-speed loom industrial interconnection remote monitoring system is designed from the hardware system and the software system. The system briefly describes the data communication and data transmission between the web server and the remote client, and meets the needs of industrial sites [8]. Aiming at the current situation that the abnormal protective layer current of the cross-linked high-voltage cable system cannot accurately reflect the insulation status, this paper proposes a solution and forms a corresponding intelligent interconnection system, which effectively solves the current protection and facilitates the monitoring and maintenance of the cable [9]. In this paper, a multidevice intelligent interconnection method and system based on Bluetooth are invented. The system sends a request to the peripheral device through the central device, the peripheral device reports the service type, and repeats the above operations to complete the networking. The business connection provides convenience [10]. In this paper, the optimal decision-making problem in the TAFC task is obtained through various schemes, and its six models are analyzed to further prove the optimal trade-off between speed and accuracy. Performance makes new predictions [11]. This paper describes that learning the value of options in an uncertain environment is the core of optimal decision-making, and proves that the ACC does not detect errors and correct them, but guides, and does not maintain reward responses after ACC damage, nor does it integrate risk and earnings [12]. This paper studies the optimal data fusion problem in the sense of Neyman-Pearson (NP) test in a centralized fusion center. Examples are derived from the constraints on the sensor system, channel capacity, etc., and provide a method for adjusting the threshold level at the fusion center [13]. In this paper, *Clethrionomys glareolus* was studied through food addition grids and control grids, and six conclusions were drawn using the capture-mark technique. Finally, there was no evidence that delayed maturation in voles was the best strategy for evolution [14]. This paper studies the optimal data fusion problem in the sense of Neyman-Pearson (NP) test. The fusion center receives data and then performs the NP test by the sensor. The results show that multiple sensors are also possible for the system. Finally, a method for adjusting the threshold is obtained [15].

2. Blockchain-Related Content

2.1. Background of Blockchain. The emergence of Bitcoin in 2008 has led to a new round of technological revolution and the rapid development of related industries. The blockchain was born and swept the Internet and traditional economic circles at a lightning-fast speed. The blockchain is an Internet database technology, which divides data into many blocks and then passes through some kind of secret. A technology connects them into a data network, which is different from traditional databases. The data in the blockchain is safe and shared, so it can also be seen as a distributed and shared data library. Blockchain is a decentralized distributed storage technology that can establish trust relationships without a network. At present, blockchain is mainly used in research in many fields such as Internet of Things, financial services, electronic depository, digital identity, and education. They can be divided into three types of blockchains: public chain, private chain, and alliance chain. Different blockchain types are aimed at different application scenarios, and they have their own advantages and disadvantages, so they are divided into three types of blocks. Blockchains are uninterrupted digital transactions of economic transactions that can be programmed to record almost anything of value, not just financial transactions. Simply put, it is a decentralized database containing data that cannot be modified, managed by a cluster of computers, and not owned by any one party. Blockchains are saved as databases or flat files.

2.2. Design Concept Based on Alliance Chain. In the application field of alliance blockchain, when all nodes receive the transaction file, they will reach a consensus on a set of bit vectors. When the transaction size is greater than or equal to 250 bytes and the number of nodes is about 100, the performance effect is greatly improved. From another angle to analyze the blockchain, we can find that it is actually a distributed system. Brewer's theorem is an important theory in distributed systems, indicating that distribution can be divided into consistency, availability, and partition fault tolerance. Consistency is related to the degree of data or state consistency between different entities in a distributed system. From a practical point of view, consistency actually reflects the uniqueness of the system to the services provided by the client; availability is that the system can continue to send requests when there are roadblocks within the distributed system; partition fault tolerance is that the system divides data into. There are many different types and they are divided into different areas for storage according to their types. If there is a problem in one area, it will not imagine the normal work of other areas, and will not affect the operation of the system.

2.3. Blockchain Technology. The essence of blockchain technology is the decentralization and decentralization of data storage, transmission, and authentication as a technical area. It is used to replace the current Internet dependency on a central server, which then records all data changes or transaction items. In the cloud system, in-transit analysis is theoretically completed. Broadly speaking, it goes beyond traditional methods of verifying information that must rely on a central location, reducing the cost of establishing a global "credit." This new approach indirectly demonstrates the "foundation protocol" that creates the foundation of distributed artificial intelligence. A new share interface is created between human brain intelligence and machine intelligence.

2.4. Relevant Features of Blockchain

2.4.1. Features of Blockchain. Blockchain is a distributed digital ledger that keeps pace with the times. It has the following four characteristics: 1. Distributed ledger: The blockchain is just like taking notes when we listen to lectures. It has a security record for every transaction in the Internet, and there will be no unknown transactions or forgetting transactions. Situation is highly secure and available. 2. Irreversibility: From the public's understanding of the blockchain, one of the cornerstones of the blockchain is nontampering, so people will not work in this opposite direction. Theoretically, it is possible to reverse the transaction, but this requires 51% of the computing power to recognize your reversal. Logically speaking, this is actually an economic game theory, and 51% of the computing power will not agree with your reversal. If you take 10,000 steps back and say that if you have 51% of the computing power, you have no reason to reverse and destroy. 3. Anticensorship: The blockchain itself keeps a record of every transaction, ever made, which prevents the tracking of blockchain projects. 4. Near real-time settlement: its internal time is very close to the outside world, which ensures that the customer's transaction confirmation time is almost the same, thus reducing the insecurity of the transaction party.

2.4.2. Advantages of Blockchain. Blockchain is an innovative application model of computers in the Internet era, such as distributed data storage and point-to-point transmission consensus mechanism encryption algorithm. It has five major advantages: decentralization, openness, autonomy, information immutability, and anonymity. The five basic advantages have been generally agreed upon. 1. Decentralization: refers to the use of decentralized accounting and storage in the blockchain, without centralized management. All nodes have equal rights and obligations, and system maintenance is handled by specialized maintenance nodes. 2. Openness: The so-called openness means that the blockchain system is open to the outside world. Only specific information is hidden and others are open to everyone. Anyone can query the data through a secure interface. 3. Autonomy: The autonomy of blockchain is based on specifications and protocols. Nodes in the system can freely convert data, so that they can believe that human operations cannot be changed. 4. Information cannot be tampered with: When the user's information is added to the system and confirmed, it cannot be modified. Only half of the nodes can be manipulated to modify the content, which is why the stability and reliability of the blockchain are very high. 5. Anonymous letter: It means that the exchange between nodes follows a fixed algorithm, and customers will not disclose their identities for each other to identify. These unique advantages will over time change the relationship between various industries in the future.

2.5. The Impact of the External Environment on the Blockchain System

2.5.1. Self-Factors. In the 21st century, it is very common for people to cause irreparable losses to the blockchain system due to their own operational errors. Among them, people mainly change, attack, and destroy the network system autonomously, which leads to the leakage of information and network paralysis. Many hackers will use its proficiency in computers to implant viruses on corporate or personal computers, so as to achieve their desired goals. For example, in 2012, the hacker sent a Chinese version, embedded a backdoor in the Chinese version of putty, searched many key things from Baidu, and owned his registered domain name (https://putty.org.cn.cn)), promote the site, and steal the admin. Send the SSH username and password entered by the administrator to the designated server. In March 2015, the attacker hijacked the JS script of Baidu Ad Alliance and replaced it with malware. In addition, on August 1, 2014, a large-scale denial of service attack was launched on GitHub using foreign users to access Chinese websites, according to the official Weibo account of Zhejiang Province. Hackers attacked the set-top boxes of cable TV network users, causing reactionary propaganda and affecting people's normal TV viewing, which had a negative impact. Through these events that have occurred, 75% of the crimes are out of the inside.

2.5.2. Influence of Network Resources. Resource sharing is the advantage of big data network. Whether it is from various hardware devices, software data, or a large amount of data and information, it is very convenient for users to query information and achieve effective resource sharing. In addition, not only all network users can access server resources, but also various information and data can be shared between different terminal devices. This provides a resource and many criminals use this device to steal and destroy information. This will cause huge economic losses to users and network construction. The environment has become unmanageable, and confidence in the Internet has been lost. In order to solve this problem, users should not only participate in the security of network data responsibly but also optimize the network environment, strengthen the internal firewall settings of the system, and build a safe and environmentally friendly network space for customers as much as possible.

2.5.3. Data Transfer Impact. According to relevant research, communication lines can also lead to the risk of information leakage, especially with the emergence of 5G network technology. All kinds of information technology and equipment fill people's field of vision. It has brought us a lot of convenience, but there are also a lot of security problems. In view of the current actual situation, many companies or their families have not done a good job of data shielding. Therefore, some illegal users use monitoring communication lines to obtain their personal information. Some unscrupulous people connect our computers through high-end devices. So as to opportunistically intervene in the communication interface, send them the basic information that we usually surf the Internet. In addition, there are many ways we do not know how to steal our important data, such as illegality. There will be intrusion, illegal use, injection of illegal information, line interference, etc. in the

communication line, so sufficient measures must be taken to protect the security of data communication.

2.5.4. Virus Effects. Factors that affect the failure of network security defenses include the intrusion of computer viruses that control the behavior of computer software and hardware, which can steal useless information. Legal activity has a huge impact on users. There are many types of computer viruses, and their attack characteristics on the device network are also different. Some viruses are responsible for infecting your files and crashing them, while others attack your computer's defenses. Therefore, it is unlikely to detect it and remove the virus completely; mainly file-type viruses which are designed to infect unused areas of the disk with viruses. Some DOS functions are often used to spread viruses. This will lead to a huge waste of disk space and will affect the normal operation of our computer. Not only will it cause our data to be lost, but it will also render our computer useless. Complexity of the blockchain itself: The blockchain network is very complex. With the increase of transaction customers and different transaction methods, this greatly reduces the stability of the blockchain system. Super high energy consumption: As far as the Bitcoin blockchain is concerned, it consumes more energy than the entire Switzerland. It is conceivable how huge the energy consumption of the entire blockchain is. Lack of skilled operators: Due to the huge and complex system of the blockchain, there are very few people who learn it, resulting in the loss of talents in this area.

3. Mathematical Model of Blockchain Market Entities

The transparency and diversification of blockchain technology can make the market better adapt to its own structure. Each of these nodes has its own smart contract data according to its own terms, such as financial information, customer information, and dynamic contracts, and can track transaction information between different users. After analysis and evaluation, we will optimize the operation strategy, provide users with optimization and transaction convenience, formulate the purchase and sale of electricity in the electricity market, and pursue the optimization of our own profits. In the multimicrogrid system, microgrid operators, large users, and decentralized aggregators participate in the market game. In order to pursue the optimization of their own profits, they are in different stages. Therefore, obtaining ultrahigh profits through competition in the market under blockchain technology is the most concerned issue of every industry.

3.1. Demands of Microgrid Operators under the Blockchain. Since the energy (wind, solar, etc.) in the blockchain microgrid is intermittent, in a unit cycle, the content sequence must be balanced with its own load, and the external environment generally provides more or less power. If the system has surplus power, the microgrid operator sells the surplus power to other microgrid operators, large users, and some individual users in pursuit of profit optimization and profit $R_{\text{sell}}^{MO}(t)$. If the system is out of power, the microgrid operator will purchase electricity from the operator with excess power in the external environment to protect itself and incur power purchase costs $C_{\text{buy}}^{MO}(t)$. At the same time, under the multi-microgrid market mechanism of blockchain technology, microgrid operators benefit from improved secondary energy utilization, the return of additional carbon emissions, and the adverse cost of additional carbon emissions. Their presentation is as follows.

3.1.1. Income from Electricity Sales $R_{sell}^{MO}(t)$

$$\begin{aligned} R_{sell}^{MO}(t) = &\sum_{i=1}^{N_1} p_{sell}^{MtoM_i}(t) Q_{sell}^{MtoMi}(t) + \sum_{j=1}^{N_2} P_{sell}^{MtoA_j}(t) Q_{sell}^{MtoA_j}(t) \\ &+ \sum_{m=1}^{N_3} p_{sell}^{MtoU_m}(t) Q_{sell}^{MtoU_m}(t) \\ &+ \sum_{q=1}^{N_4} P_{sell}^{MtoI_q}(t) Q_{sell}^{MtoI_q}(t), \end{aligned} \tag{1}$$

where $P_{sell}^{MtoM_i}(t)$, $P_{sell}^{MtoA_j}(t)$, $P_{sell}^{MtoU_m}(t)$, and $P_{sell}^{MtoI_q}(t)$ are the electricity sales prices of the i-th microgrid operator, the j-th distributed aggregator, the m-th large user, and the q-th individual user in time period t, respectively; $Q_{sell}^{MtoMi}(t)$, $Q_{sell}^{MtoA_j}(t)$, $Q_{sell}^{MtoU_m}(t)$, and $Q_{sell}^{MtoI_q}(t)$are the electricity sales of the i-th microgrid operator, the j-th distributed aggregator, the m-th large user, and the q-th individual user at time t, respectively; N_1 is the number of microgrid operators; N_2 is the number of distributed aggregators; N_3 for a large number of users; N_4 is the number of individual users.

3.1.2. Cost of Purchasing Electricity $C_{buy}^{MO}(t)$

$$\begin{aligned} C_{buy}^{MO}(t) = &\sum_{\text{i}=1}^{N_1} c_{buy}^{M_i toM}(t) Q_{buy}^{M_i toM}(t) \\ &+ \sum_{j=1}^{N_2} c_{buy}^{A_j toM}(t) Q_{buy}^{A_j toM}(t). \end{aligned} \tag{2}$$

$c_{buy}^{M_i toM}(t)$ and $c_{buy}^{A_i toM}(t)$ are the unit prices of electricity purchased by the ith microgrid operator and the jth distributed aggregator during t, respectively; $Q_{buy}^{M_i toM}(t)$ and $Q_{buy}^{A_i toM}(t)$ are the electricity purchased by the ith microgrid operator and the jth distributed aggregator in time period t, respectively. It depends on whether the system has electricity. When the system has no electricity, it will buy electricity from the outside to maintain its own operation, which will generate electricity purchase costs; when the system has excess electricity, it will sell part of the electricity to gain revenue. This will generate profit. This is the only formula: net profit from selling electricity = revenue from selling electricity − cost of buying electricity.

3.1.3. Incentive Benefits and Penalty Costs

$$R_{\text{bonus}}^{MO}(t) = (i - i_{re})R_{\text{bonus}}(t),$$
$$R_{\text{bonus}}^{MO}(t) = (i - i_{re0})R_{\text{bonus}}(t), \quad (3)$$

where $R_{\text{bonus}}^{MO}(t)$ is the reward income at time t; i_{re} is the efficiency that can be reused at present, and i_{re0} is the standard for system renewable energy. $R_{\text{bonus}}(t)$ It is the benefit obtained by improving the efficiency of secondary energy by 1 point each time; $C_{\text{extre}}^{MO}(t)$ is the unfavorable cost of time period t; $H_{co2}(t)$ is the current carbon production; $H_{co2}(t_0)$ is the amount of carbon emissions it may generate; and $c_{extre}(t)$ is the unfavorable cost for each additional unit of carbon emissions. This system can only be triggered when the disadvantage factor is greater than the advantage condition, and then the utilization rate of renewable energy can be improved.

3.1.4. Distributed Power Output Subsidy Income

$$R_{Subsidy}^{MO}(t) = \sum_{k=1}^{a_1} Q_{solar}^{k}(t)P_{solar}^{Subsidy} + \sum_{u=1}^{a_2} Q_{wind}^{u}(t)P_{\text{wind}}^{Subsidy}. \quad (4)$$

$R_{Subsidy}^{MO}(t)$ is the subsidy benefit of distributed power sales in time t; $Q_{\text{solar}}^{k}(t)$ is the amount of electricity generated by the kth photovoltaic power source within time t; $P_{\text{solar}}^{\text{Subsidy}}$ is the subsidy benefit of generating one unit of electricity for photovoltaics, the unit is yuan/(kW·h); $Q_{wind}^{u}(t)$ is the power generation quantity of the uth wind power in time period t; $P_{\text{wind}}^{Subsidy}$ It is the discounted loss benefit of wind power generation, the unit is yuan/(kW·h); a_1, a_2 are the amounts of photovoltaic and wind power generated by the microgrid operator, respectively.

3.2. The Main Needs of Major Users $C_{buy}^{MtoU}(t)$,$C_{buy}^{AtoU}(t)$. As the energy consumers on the demand side, the main purpose of large users is to obtain the target electricity produced at the lowest cost. Some large users also have specific power generation capabilities to sell excess power outdoors. This paper simplifies the model, assuming that the main users of the multimicrogrid system are not qualified to generate electricity. Considering only the purchase of electricity by large users, the purpose of most large users to purchase electricity includes the cost of purchasing electricity from the microgrid operator $C_{buy}^{\text{MtoU}}(t)$ and the cost of purchasing electricity at the distributed aggregator $C_{buy}^{AtoU}(t)$. The specific form of electricity purchase depends on the electricity sales strategy of each business.

3.2.1. Purchases Electricity from the Operator of Weidian.com

$$C_{buy}^{MtoU}(t) = \sum_{i=1}^{N_1} c_{buy}^{M_i toU}(t)Q_{buy}^{M_i toU}(t). \quad (5)$$

where $C_{buy}^{MtoU}(t)$ is the unit cost of electricity purchased by large users from the i-th microgrid operator during time period t; $Q_{buy}^{M_i toU}(t)$ is the amount of electricity purchased by large users from the i-th microgrid operator during time period t.

3.2.2. Purchase Electricity from Distributed Aggregators

$$C_{buy}^{AtoU}(t) = \sum_{j=1}^{N_2} c_{buy}^{A_j toU}(t)Q_{buy}^{A_j toU}(t). \quad (6)$$

where $c_{buy}^{A_j toU}(t)$ is the unit cost of electricity purchased by large users from j aggregators during period t; $Q_{buy}^{A_j toU}(t)$ is the amount of electricity purchased by large users from the jth aggregator during period t.

3.3. Distributed Aggregator Requirements. Blockchain technology will automatically generate smart contracts, collect and store distributed secondary energy, centrally manage distributed energy, and realize transactions. Coordinated control of various power generation resources by distributed aggregators constantly requires customers to enter the power market, and concord is also a fast consumption method for realizing energy. Decentralized aggregators mainly use bid-ask spreads to maximize profits. They buy electricity at the lowest cost on the one hand and sell it at the highest profit on the other. The specific performance is as follows.

3.3.1. Cost of Purchasing Electricity from Abroad

$$C_{buy}^{out}(t) = \sum_{i=1}^{\partial_1} P_{wind}^{i}(t)Q_{wind}^{i}(t) + \sum_{j=1}^{\partial_2} P_{solar}^{j}(t)Q_{solar}^{j}(t) + \sum_{m=1}^{\partial_3} P_{other}^{m}(t)Q_{other}^{m}(t). \quad (7)$$

∂_1, ∂_2, ∂_3 are the number of wind power users, the number of photovoltaic power generation users, and the number of other distributed generation users; $P_{wind}^{i}(t)$, $P_{solar}^{j}(t)$, and $P_{other}^{m}(t)$ are the prices at which the manufacturer purchases distributed electricity from wind power users, photovoltaic power users, and other distributed generation users in time period t; $Q_{wind}^{i}(t)$, $Q_{solar}^{j}(t)$, and $Q_{other}^{m}(t)$ are the wind power generation, photovoltaic power generation, and other distributed generation power purchased by the manufacturer in time period t, respectively.

The cost of purchasing electricity from a microgrid operator:

$$C_{buy}^{MtoA}(t) = \sum_{j=1}^{N_1} c_{buy}^{M_j toA}(t)Q_{buy}^{M_j toA}(t). \quad (8)$$

$C_{buy}^{MtoA}(t)$ is the unit cost of electricity purchased by the distributed aggregator to the i-th microgrid operator at time t; $Q_{buy}^{M_j toA}(t)$ is the electricity purchased by the distributed aggregator from the ith microgrid operator in time t.

Power purchase cost from other distributed aggregators:

$$C_{buy}^{AtoA}(t) = \sum_{j=1}^{N_2} c_{buy}^{A_j toA}(t) Q_{buy}^{A_j toA}(t). \quad (9)$$

$c_{buy}^{AtoA}(t)$ and $Q_{buy}^{A_j toA}(t)$ are the unit power purchase cost and the amount of power purchased by the manufacturer from other jth submanufacturers in period t, respectively.

3.3.2. Energy Storage Operating Costs

$$C_{run}^{batterys}(t) = c_{run}^{A_j}(t) Q_{battery}^{A_j}. \quad (10)$$

$C_{run}^{batterys}(t)$ is the energy storage operation cost of distributed aggregator j in time t; $c_{run}^{A_j}(t)$ is the unit operating cost of energy storage for distributed aggregator j in time t; $Q_{\text{battery}}^{A_j}$ is the unit operating cost of energy storage for distributed aggregator j in time t; $Q_{\text{battery}}^{A_j}$ is the energy storage capacity of distributed aggregator j.

3.3.3. C Income from Electricity Sales. Proceeds from selling electricity to microgrid operators:

$$R_{sell}^{AtoM}(t) = \sum_{i=1}^{N1} P_{sell}^{AtoM_i}(t) Q_{sell}^{AtoM_i}(t). \quad (11)$$

$P_{sell}^{AtoM_i}(t)$ and $Q_{sell}^{AtoM_i}(t)$ are the electricity price and electricity sold to microgrid operator i in time t, respectively.

Revenue from selling electricity to large users:

$$R_{sell}^{AtoU}(t) = \sum_{m=1}^{N_3} P_{sell}^{AtoU_m}(t) Q_{sell}^{AtoU_m}(t). \quad (12)$$

$P_{sell}^{AtoU_m}(t)$ and $Q_{sell}^{AtoU_m}(t)$ are the electricity price and electricity sold to large user m in time period t, respectively.

Benefits of selling electricity to other distributed aggregators:

$$R_{sell}^{AtoA}(t) = \sum_{j=1}^{N_2} P_{sell}^{AtoA_j}(t) Q_{sell}^{AtoA_j}(t). \quad (13)$$

$P_{sell}^{AtoA_j}(t)$ and $Q_{sell}^{AtoA_j}(t)$ are the electricity price and electricity sold to other distributed aggregators j during time period t, respectively.

3.4. Noncooperative Game Model

3.4.1. Game Subject. The game theme of the multimicrogrid market competition game model studied in this paper is mainly the power purchase demand of NM microgrid operators, NU large users, and NA decentralized energy aggregators in a period of time, which is expressed as

$$\Gamma\{M_1, M_2, \ldots, M_{NM}, U_1, U_2, \ldots, U_{NU}, A_1, A_2, \ldots, A_{NA}\}. \quad (14)$$

3.4.2. Policy Space P(t). The game strategy of each market entity is the unit price of electricity purchase $C_{buy}(t)$ and electricity price $P_{sell}(t)$ (the unit is Yuan/(kWh)). The unit price of the microgrid operator is actually the selling price of the power company in period t. Therefore, microgrid operators can temporarily ignore the unit price of electricity according to the established strategy. To maximize your own profits, just sell on a case-by-case basis. In this way, the electricity sales method of the microgrid operator i is: $\eta_{sell}^{M} = \left\{P_{sell}^{MtoA_j}(t), P_{sell}^{MtoA_j}(t), P_{sell}^{MtoU_m}(t), P_{sell}^{MtoI_q}(t)\right\}$. Large customers cannot sell electricity. A series of market game strategies are mainly reflected in the low cost of electricity purchase: $\eta_{buy}^{U} = \left\{c_{buy}^{M_j toU}, c_{buy}^{A_i toU}\right\}$. Most distributed consumption points mainly collect distributed power through energy storage and use the bid-ask spread to make indirect profits. The scope of the game strategy reflects the electricity price in electricity sales: $\eta_{sell}^{A} = \left\{P_{sell}^{atoM_i}(t), P_{sell}^{AtoU_m}(t), P_{sell}^{AtoI_q}(t)\right\}$.

3.4.3. Objective Function F. The competitive game goal of microgrid operators, large users, and decentralized aggregators are to maximize their profits, that is, to get more income with the least labor cost and the objective function is as follows.

(1) The Objective Function of the Microgrid Operator is

$$\begin{aligned}
\max \prod_{MO}(t) &= R_{sell}^{MO}(t) - C_{buy}^{MO}(t) + R_{bonus}^{MO}(t) - C_{Subsidy}^{MO}(t) \\
&= \sum_{i=1}^{N_1}\left(P_{sell}^{MtoM_i}(t) Q_{sell}^{MtoM_i}(t) - c_{buy}^{M_i toM}(t) Q_{\text{buy}}^{M_i toM}(t)\right) \\
&+ \sum_{j=1}^{N_2}\left(P_{sell}^{MtoA_i}(t) Q_{sell}^{MtoA_i}(t) - c_{buy}^{A_j toM}(t) Q_{\text{buy}}^{A_j toM}(t)\right) \\
&+ \sum_{m=1}^{N_3} P_{sell}^{MtoU_m}(t) Q_{sell}^{MtoU_m}(t) + \sum_{q=1}^{N_4} P_{sell}^{MtoI_q}(t) Q_{sell}^{MtoI_q}(t) \\
&+ (i_{re} - i_{re0}) R_{bonus}(t) - c_{extre}(t)\left(H_{co2}(t) - H_{co2}\right)(t_0) \\
&+ \sum_{k=1}^{a_1} Q_{solar}^{k}(t) P_{solar}^{Subsidy} + \sum_{u=1}^{a_2} Q_{wind}^{u}(t) P_{wind}^{Subsidy}.
\end{aligned} \quad (15)$$

The objective function for large users is

$$\begin{aligned}
\min C_U(t) &= C_{buy}^{MtoU}(t) + C_{buy}^{AtoU}(t) \\
&= \sum_{i=1}^{N_1} c_{buy}^{M_i toU}(t) Q_{buy}^{M_i toU}(t) \\
&+ \sum_{j=1}^{N_2} c_{buy}^{A_j toU}(t) Q_{buy}^{A_j toU}(t).
\end{aligned} \quad (16)$$

The objective function of the c distributed aggregator is

$$\max \prod_{A}(t) = R_{sell}^{AtoM}(t) + R_{sell}^{AtoU}(t) + R_{sell}^{AtoA} - C_{buy}^{out}(t) - C_{run}^{batterys}(t) - C_{buy}^{MtoA}(t) - C_{buy}^{AtoA}(t). \tag{17}$$

(2) Constraints.

(2) Constraints for Microgrid Operators

Distributed generator set output constraints:

$$\begin{aligned} 0 < L_{wind}^{a}(t) < L_{wind}^{\max}(t), \\ 0 < L_{solar}^{\beta}(t) < L_{wind}^{\max}(t), \\ L_{MT,\min}^{\theta M}(t) < L_{MT}^{\theta}(t) < L_{MT,\min}^{\theta}(t). \end{aligned} \tag{18}$$

Electricity sales constraints:

$$\begin{aligned} 0 \le & \sum_{i=1}^{N_1} Q_{sell}^{MtoM_i}(t) + \sum_{m=1}^{N_3} Q_{sell}^{MtoU_m}(t) + \sum_{j=1}^{N_2} Q_{sell}^{MtoA_j}(t) \\ & + \sum_{q=1}^{N_4} Q_{sell}^{MtoI_q}(t) \\ & \le \left(\sum_{a=1}^{\partial_1} L_{wind}^{a}(t) + \sum_{\beta=1}^{\partial_2} L_{solar}^{\beta}(t) + \sum_{\theta=1}^{\partial_3} L_{MT}^{\theta}(t) - \sum_{i=1}^{N_1} L_{load}^{MO_i}(t) \right) \Delta t. \end{aligned} \tag{19}$$

Electricity price constraints:

$$P_{\min}(t) \le \left\{ P_{sell}^{MtoM_i}(t), P_{sell}^{MtoA_j}(t), P_{sell}^{MtoU_m}(t) \right\} \le P_{\max}(t). \tag{20}$$

(3) Constraints of Large User Principals

Electricity purchase constraints:

$$\sum_{i=1}^{N_1} Q_{buy}^{M_i toU}(t) + \sum_{j=1}^{N_2} Q_{buy}^{A_j toU}(t) \ge Q_{buy}^{U}(t). \tag{21}$$

Electricity purchase price constraints:

$$\ell_{buy}^{U} = \left\{ c_{buy}^{M_i toU}, c_{buy}^{A_j toU} \right\} \le c_{buy}^{U}(t). \tag{22}$$

(4) Constraints of Distributed Aggregators

Energy storage battery power constraints:

$$L_{ESS}^{\min} \le L_{ESS}(t) \le L_{ESS}^{\max}. \tag{23}$$

Electricity sales restrictions:

$$\begin{aligned} 0 \le & \sum_{i=1}^{N_1} Q_{sell}^{AtoM_i}(t) + \sum_{m=1}^{N_3} Q_{sell}^{AtoU_m}(t) \\ & \le \sum_{a=1}^{\ell_1} Q_{wind}^{a}(t) + \sum_{\beta=1}^{\ell_2} Q_{solar}^{\beta}(t) + \sum_{\theta=1}^{\ell_3} Q_{other}^{\theta}(t). \end{aligned} \tag{24}$$

Electricity price constraints:

$$P_{\min}(t) \le \left\{ P_{sell}^{AtoM_i}(t), P_{sell}^{AtoU_m}(t) \right\} \le P_{\max}(t). \tag{25}$$

(5) Improvement Method

In a multimicrogrid, if the parameters a and b are not selected correctly, it will directly affect the speed of the experimental solution and the effect of the solution. In order to improve the ACO calculation performance, the parameters a, b can be defined as

$$\begin{aligned} a &= 1 + e^{-0.1N_{\max}}, \\ b &= \frac{2.5}{e^{1-a} + 1}. \end{aligned} \tag{26}$$

where $N_{\max}$ is the maximum number of repetitions and it can control one parameter to control multiple other parameters, which enhances the liquidity between them. Formulas (23) and (24) are further improvement formulas for the electricity sold by the multimicrogrid. They can make the system run more efficiently and finally help customers get the maximum benefit. If there is no improved formula, not only the whole system is running, there is a high probability that the system will crash due to the huge data, so these two formulas are essential.

4. Experiment and Analysis of Multimicrogrid under Blockchain

4.1. Overall Model Diagram of Blockchain Power System. Figure 1 shows that the power system under the blockchain operates cyclically. At the beginning, it is necessary to find suitable data information in the big environment of the blockchain. After finding, the power dispatching plan is automatically generated according to the matching dispatching model and dispatching strategy. Intelligent adjustment is made according to different power generation conditions, and finally the data is updated and the sorted results are fed back to the dispatching model for improvement. First, the transaction information must be collected in the blockchain, and then spread to the entire network through the P2P network in the form of smart contracts. The nodes will synthesize blocks and reach a consensus. If the security check is met, proceed to the next step. To prevent it from running, the data that has passed is collected by the smart meter and recorded in the blockchain. After the transaction time, the system automatically completes the value transfer.

4.2. Transaction Analysis and Comparison of Multimicrogrid Interconnection Systems. Figures 2 and 3, respectively, show the daily average transaction price and transaction volume of the multimicrogrid interconnection system. Looking at Figure 1 alone, the final average transaction price of the multimicrogrid system is located in the middle of the electricity selling price and the on-grid electricity price. Compared with the previous traditional transaction model of "setting the price to go online, the remaining amount is connected to the Internet," the producer can have more

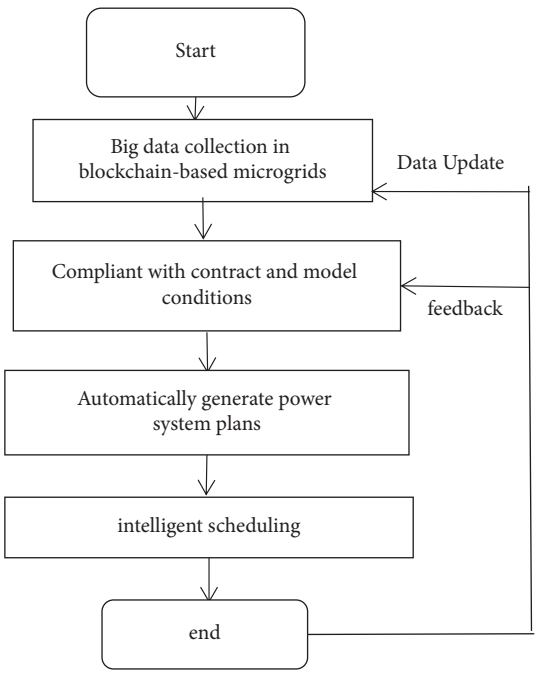

Figure 1: Power system diagram.

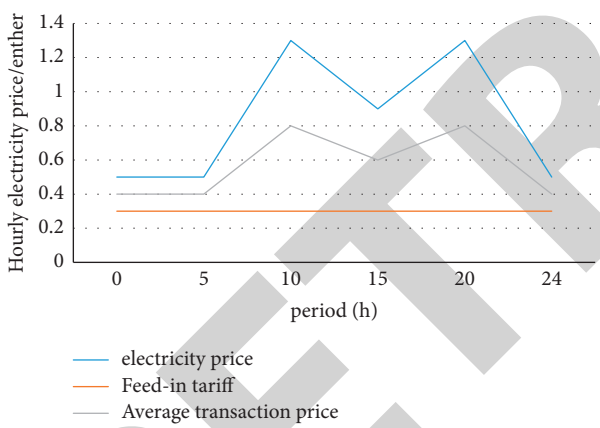

Figure 2: Average electricity price in different time periods.

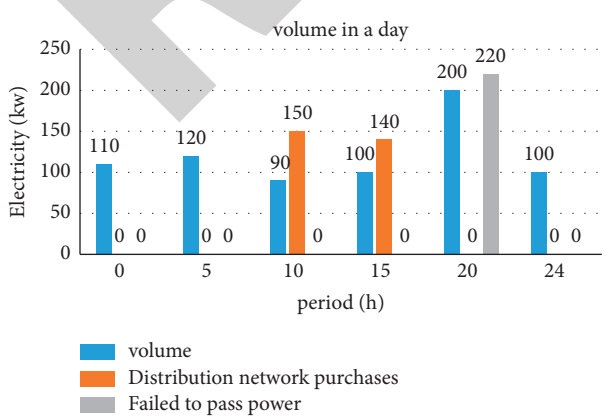

Figure 3: All day volume.

electricity sales benefits on the trading platform, and consumers can save more electricity bills. As shown in Figure 2, the multimicrogrid system can meet the needs of most electricity purchasers, but at 7:00–15:00, due to the problem of the producer, the electricity sold is not enough, which will make the generator set of the backup scheme. The group provides the electricity required by consumers. The time period from 19:00 to 20:00 is that the platform has not passed the dynamic constraint check, and transactions cannot be performed during this period. The average electricity price of multiple microgrids will vary with time during the day. Between 10:00 and 15:00, the multimicrogrid system will purchase electricity to meet the needs of customers due to lack of electricity, which will lead to an increase in electricity prices and increase customer consumption. It is not difficult to see from the comparison of the two figures that the transaction volume will affect the average electricity price; as the transaction volume increases, the electricity price will also increase.

Figure 4 shows the optimal electricity prices provided by different operators at different times under the multimicrogrid interconnection system. From the above data, it can be seen that the customer's electricity demand reaches its peak in the morning, and these markets sell electricity at higher prices. Use this time to get the best benefit. When the price for large users reaches the best moment, the microgrid operator sets the price of electricity sales at 1.6 yuan/(kw·h), while the price of distributed aggregators is up to 1.7 yuan/(kw·h). If the price of the distributed aggregator is lower than the price of the microgrid, it will not generate high profits, so the price of the distributed aggregator is set at 1.7 yuan/(kw.h), At this time, both parties achieve the optimal effect.

4.3. Multimicrogrid Self-Value Method and Dynamic Constraint Analysis. In order to reflect the obvious comparison, Figure 4 compares the fixed aggressive values of 0.05, 0.09, 0.12, the zero-information strategy, and the ZI aggressive value. It can be seen from Figure 5 that the ZI aggressive value is in the range of (0.05, 0.09). This data experiment Fair and accurate. As can be seen from the figure, the average values obtained by these methods are very similar. The number of transaction cycles of the adaptive aggressive value is less than that of other methods, because the value it selects is the data selected from the market, and the size of the value can be determined in the system to improve the success of trading between customers.

Figure 6 shows the optimization decision for voltage offset in a multimicrogrid system. It can be seen from the figure that under the condition of no voltage offset constraint of multimicrogrid, after meeting the customer's demand, the producer will put the surplus power into the storage grid to obtain greater profits. This makes the voltage excursion range of the node larger than the constraint. For the voltage offset between 0.890 pu and 1.110 pu, the voltage offset with constraints and without constraints accounts for 97.2% and 93.5%, respectively, so the voltage offset with constraints is more advantageous in multimicrogrid systems. The presence or absence of the voltage offset constraint

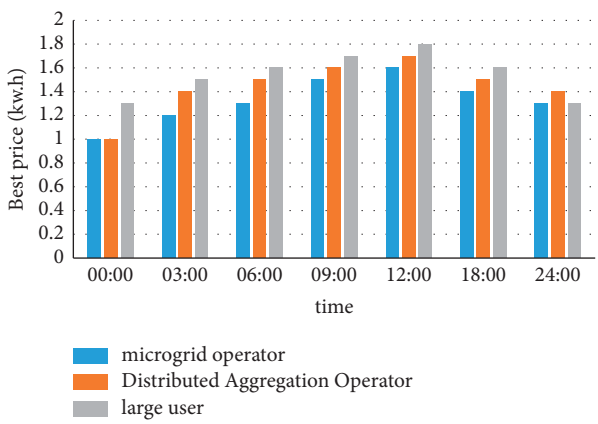

Figure 4: Carrier's best price.

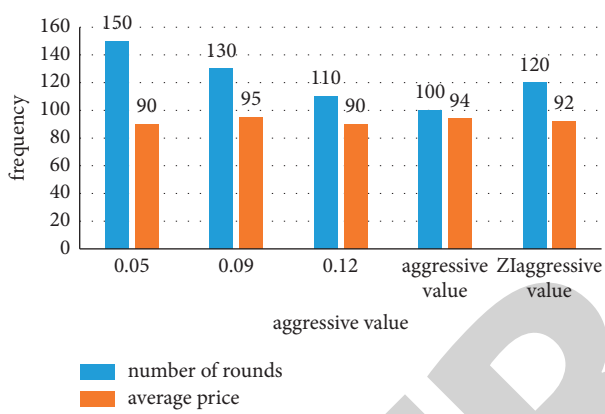

Figure 5: Progressive value comparison.

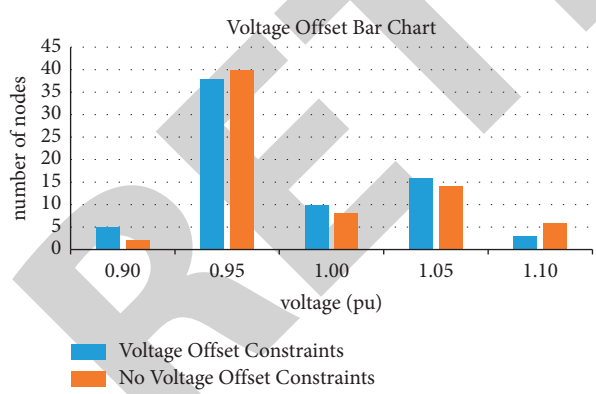

Figure 6: Voltage offset.

has little effect on the electricity sold by the multimicrogrid. In these two cases, their electricity prices are basically the same; and the number of affected nodes in these two environments differs by a single digit. Nodes are negligible in the grid system. Voltage offset constraints are optional, but the voltage offset with constraints is more stable and reliable in the system.

Table 1 shows the power flow distribution of each branch with dynamic constraint check without dynamic constraint check from Table 1 at 19:50 in the multimicrogrid time period. It can be seen that the none of the trends exceeded their limits.

Table 1: Comparison of the flow of each branch.

Branch route	Effective nuclear current (kw)	Ineffective nuclear current (kw)
6–7	100	110
7–8	100	110
8–9	100	110

Table 2: Transaction results.

Trading client	Price (ether/(kw.h))
z-x	0.66
x-c	0.65
v-b	0.71

4.4. Smart Contract Transaction Details. Tables 2 and 3 show the experimental status, transaction results and transaction information of the multimicrogrid under the blockchain during the entire transaction cycle. It can be seen from Table 2 that the lowest bid price z on the producer side is higher than the highest bid price x on the consumer side, so all customers in the multimicrogrid adjust their bids in turn according to the adaptive aggressive value. After repeated attempts, after the real quotation provided by consumer x, the z quotation of the producer side is lower than the quotation of consumer x, and the two negotiate with each other to reach a consensus. After the successful transaction and settlement of the two, the producer's z still has excess electricity, and after the consumer c provides the real quotation, the price of x is lower than the price of c, so c matches x. However, the consumer c does not get enough electricity and the quotation reaches the quotation of the producer v, so v and c are matched, but the transaction of v and c cannot pass the dynamic constraint check, so the failure to match the two causes the transaction to fail to reach the transaction limit repeatedly. Therefore, after b on the consumer side submits the real quotation, the quotation of b is lower than that of c and higher than that of v, so v matches b, and the transaction is concluded when all conditions are met. However, at this time, v and b still have excess power, so v and b requote, and the two directly enter the next transaction until the end of the transaction. The final settlement result is that the accounts of consumers x, c and b transferred 20.00, 54.80, and 55.70 ether, respectively, and the corresponding amount of electricity was added to the accounts. Producers v and z sold 70, 110 kW·h, and they obtained the same amount of ether. The corresponding power is 55.80 and 77.10 ether.

4.5. Comparison of Transportation Efficiency, Results, and Solution Efficiency of Various Algorithms in Multimicrogrid. A. In this paper, the multiple constraints of multimicrogrids are considered in many aspects. In order to better reflect the impact of the dynamic beam method on the computational

Table 3: Transaction information.

Counterparty	Transaction address	Account before transaction (kw.h)	Pre-trade balance (ether)	Post-trade account (kw.h)	Post-trade balance (ether)
v	$1 \times 1234\ldots$	80	100	20	150.20
z	$1 \times 1s1s\ldots$	110	100	0	175.10
x	$1 \times g3g4\ldots$	0	100	40	80.50
c	$1 \times f4g6\ldots$	0	100	85	44.30
b	$1 \times g4h6\ldots$	0	100	80	43.60

efficiency, we compare the transaction time with the computational complexity of participating customers. The trading time of the experiment is set in the table generated when the first microgrid user publishes the actual offer. Moreover, in order to better compare the computing efficiency of smart contracts and traditional transaction modes, the experiment simulated the highest trend of traditional centralized transaction mode and smart contract mode. All the experimental results are shown in Table 4. It can be seen that the gas cost of the constrained platform is higher than that of the unconstrained platform, so that the experimental conclusions are in line with their actual calculation amount.

In terms of time comparison, the time difference between the constrained platform and the unconstrained platform is almost the same, which shows that the gas cost of the dynamic constraint method is relatively high, but its computing efficiency is guaranteed and can meet the actual situation of customers. In Matlab, the time of the smart contract mode is much lower than the time of the traditional mode. This comparison highlights that the decentralized transaction model is more excellent than the traditional method. The computing time of both platforms is greater than that of the smart contract model., which is a difference caused by their different mechanisms: it requires operating on the platform interface, although the platform takes much more time than them, but it has security and consistency that the latter two cannot compare in response to this problem. Table 4 gives specific data so that we can clearly recognize its advantages; the experiment comprehensively lists four experimental objects, and the smart contract model is far superior to the other three types in terms of transaction time and cost.

B. It can be seen from Table 5 that the average times of IACO and ACO are lower than GA and PSO algorithms, which reflects ACO. The overall convergence ability of GA is higher than that of GA and PSO algorithms. In addition, the IIMO, IIA, and CU of IACO and ACO are better than GA and PSO algorithms, indicating that the overall convergence ability of ACO is also better than that of GA and PSO algorithms. This is a microgrid system under the ACO multiblockchain network. It is a powerful detection function and efficient solution to optimization problems, so people will choose this algorithm to manage their own blockchain in most cases, and its various experimental results show its advantages, which makes us more firmly believe it. Through the experimental data in Figure 5, the average number of times of IACO is less than that of ACO, and the IIMO, IIA, and CU of IACO are higher than those of ACO, which indicates that the evolution of volatile factor Q and control

Table 4: Running results.

Types of	Time (s)	Cost
Binding platform	6	152621
Unconstrained platform	7	15232
Pretraditional trading model	1.10	0
Smart contract mode	0.50	0

Table 5: Comparison of optimization results of each algorithm.

Algorithm	Average times	IIMO/Yuan	IIA/Yuan	CU/Yuan
LACO	60	293296.5	291233.2	286523.2
ACO	70	266152.3	256326.2	275636.2
GA	90	256362.2	255312.1	302633.2
PSO	95	256362.1	245632.2	312635.2

factors b and d indirectly increases the normal frequency. The overall detection ability and convergence ability of ACO improves the computing efficiency, which leads to better results. Finally, we draw the final conclusion on the overall analysis: based on the basic characteristics of the blockchain system and ACO, we have made experiments on this. Table 5 shows the general operation steps and processes of this experiment. IACO has better overall detection ability and convergence function when solving blockchain multi-objective problems, and the solving efficiency is far greater than other algorithms.

C. In addition, the follow-up experiments compared and analyzed the solution efficiency of IACO, ACO, and PSO algorithms in the blockchain for various main competition models of multimicrogrid. As can be seen from Figure 7, the experiment analyzed four algorithms. The solution efficiency of them under different network nodes is made. When the number of network nodes is 10, the figure shows that IACO is slightly higher than the other three algorithms, but the difference between them is not large; however, as more and more network nodes are added later, the internal algorithm model becomes larger and larger., more and more complex, the solution efficiency of ACO has become more excellent, and the calculation time in the same scale is equal to that of GA and PSO algorithms, which proves that the decentralization ability of ACO strengthens the communication between blockchain subjects. The model can be solved more effectively. In addition, with the continuous addition of nodes, it can be seen from the figure that PSO and GA will eventually overlap, and it can also be seen that the solution efficiency of IACO is higher than that of ACO, indicating that the continuous changes to the algorithm enhance the

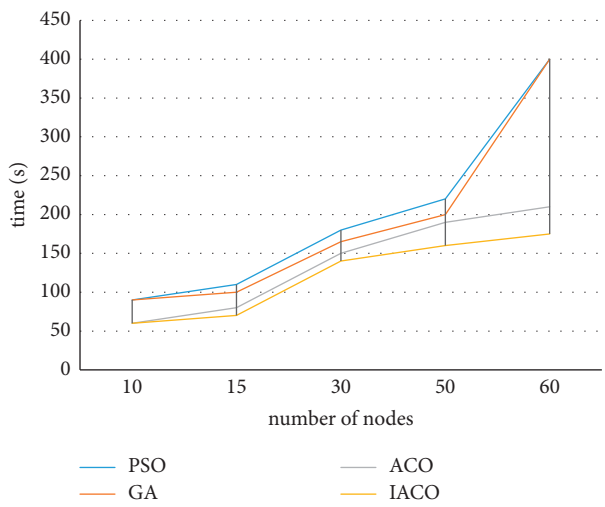

Figure 7: Solving efficiency diagram of each algorithm.

overall detection ability and rapid convergence of ACO, ability, and then improve the efficiency of IACO solution. It can be seen from Table 5 that the average convergence times of GA are lower than that of PSO, and IIMO, IIA, and CU are all better than PSO, which proves that GA is more suitable for multimicrogrid system than PSO; Figure 7 also confirms this. It is just that with the continuous addition of nodes, their solution efficiency overlaps, which shows that the difference between them will gradually decrease with the size of the system and eventually shrink to negligible.

5. Conclusion

The theme of this paper is the optimal decision-making of intelligent interconnected systems based on blockchain, in which the background, design concept, related characteristics, and unfavorable factors of blockchain are studied. Experiments are also designed, and the market competition of multimicrogrid systems is established by analyzing game problems, microgrid operators, large users, distributed blockchain technology-based aggregators, and other market player's needs and thoroughly consider local multi-microgrid. A competitive game model for the grid market competitive relationships among multiple disciplines and their goals. Through a variety of diagrams and tables, the decentralization shared by the blockchain network and ACO is based on the characteristics of IACO. We propose a general method and procedure to solve the multimicrogrid market competition based on IACO. Compared with the algorithms of ACO, GA, and PSO, IACO solves multiple problems under the blockchain technology and has better overall detection and convergence capabilities. This method can comprehensively analyze the advantages and disadvantages of the algorithm in the multimicrogrid network through experiments. The experimental process is simple and fast, and the charts drawn in the later summary are clear and clear; through comparison, it is concluded that IACO solves multiobjective problems under blockchain technology. The global search ability and convergence ability are stronger, and the solution efficiency is higher.

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.

Acknowledgments

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Retraction

Retracted: Application of Deep Learning Algorithm in Web Page Advertising Design Style

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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Research Article

Application of Deep Learning Algorithm in Web Page Advertising Design Style

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With the development of deep learning algorithm in Internet web pages and customers' demand for web advertising design, different businesses begin to pay attention to web advertising design style. In order to predict and promote the development of web advertising design style, this paper studies the establishment process of web design model based on deep learning algorithm in detail. With the application of this model to the web advertising design of different businesses, this paper compares and analyzes the differences of web advertising design styles of different businesses and puts forward corresponding suggestions on web advertising design styles, which promotes the diversified development of web advertising design styles to a certain extent and has a good application effect.

1. Introduction

With the progress of the national economy, the superior level of residents' life gradually tends to be stable and the increase of per capita income, and there must be a higher demand for the quality of life, including the spiritual demand for material aesthetics, which finally stimulates the development of design [1].

For contemporary people's life, the penetration rate of the Internet is higher and higher, and the relationship between people is also closer and closer. E-commerce has driven the emerging logistics industry, reduced the demand for social work, and provided job opportunities for more people. But at the same time, the traditional way of shopping has suffered great challenges. If you choose to open a physical store offline, high costs such as rent, wages, and expenses among manufacturers cannot be avoided. Therefore, when the pricing goods are considered, the gap between the final selling prices will not be large. For businesses on e-commerce websites, the cost has been greatly reduced, and their pricing will be much lower than that of physical stores [2]. At the same time, more preferential forms can be considered. Therefore, for prices lower than those in physical stores, consumers will spend their money on online shopping to a great extent. Moreover, the long time-consuming offline shopping, limited product types, and unnecessary energy and financial resources have greatly prompted consumers to choose online shopping. However, the shopping mode of the Internet is mostly completed in an untouchable space, which is relatively lack of direct sensory cognition.

If it is an offline shopping mall, people can have a direct experience of color of the product and the size of the product. These direct feelings improve the customer experience and further stimulate consumption. However, these direct contacts are not what e-commerce websites can do [3]. Many people worry about the difference between the size and color of products displayed on the Internet, as well as the quality of products displayed on the Internet. Such concerns can be effectively alleviated or even eliminated offline.

Web shopping has the following advantages: (1) you can fully understand the products you are interested in without going out, such as the appearance, specifications, parameters, functions, and prices of the products. (2) It can

exchange relevant commodities with a large number of netizens who have common interests and hobbies, which is convenient for future use. (3) You can buy many items that are not common in shopping malls. (4) Online shopping can often get more affordable prices and services. However, the web interface is almost the only form for e-commerce to present commodity information. In the face of many advantages of offline shopping, in order to make the online e-commerce web page more competitive, we must carry out visual analysis and advertising design on the e-commerce web interface to form a mature product advertising design style in order to promote sales. For the sales model such as e-commerce, the visual design of e-commerce web pages must be indispensable to capture the attention of more consumers, and the visual design is definitely the first factor to determine the sales volume. Under the background of contemporary network society, good visual design will definitely bring benefits to web pages without harm. Some people even say that for e-commerce vision is sales. Although it is too firm to say so, the poor visual design of e-commerce web pages must greatly affect consumers' judgment and evaluation of things, and further affect the sales volume of web pages or pages [4].

The use of color in web design is a very important element, which affects the design effect of the whole web page. Assuming that there is no content filling in the web page, just the proper use of colors in the web page can attract people's attention. The web page color matching with harmonious collocation and comfortable visual appearance can increase visitors' favor of the website [5].

Text is the only element that transmits information in the original web interface. With the development of technology and the particularity of e-commerce web pages, it is necessary to transmit the specific data of the product and at the same time let the browser have a deeper understanding of the style and shape of the item. Commodity information transmission is a collection of text, images, colors, etc. Text to present the name, price, and other attribute information of the commodity, image to present the appearance information of the commodity, and color can convey the style of the commodity, and the dynamic effect can show the commodity to consumers in the form of multiple pictures in a limited area [3]. Therefore, in order to achieve the diversification of web advertising design style, we must find an appropriate algorithm to optimize the web page.

Algorithms in the general sense are some rules set by humans, and all the machine can do is strictly implement these rules, while machine learning algorithms are essentially algorithms that summarize rules from data without rules. That is to say, the machine learning algorithm does not directly define the rules required by the machine to work, but allows the machine to summarize the rules required for the work by itself, and in the face of different data, it will summarize different rules. It can be said that machine learning algorithms are "teach a man to fish" rather than "give a man a fish." For example, we want the machine to recognize the different facial expressions presented by human beings, but we do not use the location rules of the five senses to directly tell the machine what the expressions are [6, 7]. The image data allow the machine to summarize the rules of the facial features, facial muscle shape, and other information corresponding to various emotions. The operation process of this algorithm is the process of the machine getting the rules from the data, which is the process of "machine learning."

From the simplest linear regression to the most popular artificial neural networks, they are "learning algorithms," because these algorithms are algorithms that obtain laws from data, and "deep learning algorithms" are a kind of learning algorithms, which can almost replace "artificial neural networks" in practical use [8]. Among them, "depth" is relative to the traditional two- or three-tier artificial neural networks. The number of layers of artificial neural network used in deep learning algorithm is usually hundreds of layers. The breakthrough of the application of artificial neural network in semantic recognition is to achieve the fitting phenomenon of multi-layer neural network by using one-layer artificial neural network. As for whether the learning algorithm with only one layer of artificial neural network is called "deep learning algorithm" is only the problem of name classification, it has no practical significance. The "deep learning" in this paper tends to adopt the view repeatedly emphasized by professor Wu who participated in the creation of the "Google Brain" deep learning project in many speeches; that is, the algorithms with the property of continuously digesting data to improve the numerical solution of optimization problems are called deep learning algorithms [9, 10]. Therefore, even if there is only one layer of artificial neural network algorithm, as long as it has the above properties, it can also be called deep learning algorithm.

All machine learning algorithms, including artificial neural networks, are essentially numerical optimization problems. In other words, there is an objective function. We try to find the value of the independent variable of this function to make the value of the function as small as possible, that is, the problem of finding the minimum value of the function. This objective function is also known as the "model" of this numerical optimization problem. Different problems correspond to different objective functions [11]. In other words, different mathematical models are established. For example, different application problems have different equations listed according to the problems. For different objective functions, there are many methods to find the minimum value of the function. Even if the machine learning algorithm is used to find the minimum value of the function, this learning algorithm also has dozens of categories. Among them, artificial neural network is a more effective method to solve the "pattern recognition" problems such as image recognition, speech recognition, and semantic recognition [12].

There are two steps to do the application problem: the first step is to set up the equation, and the second step is to solve the equation. The problem we are facing now is the problem of making machines understand human words, that is, the problem of semantic recognition. Facing this problem, we must first "set up the equation" (give the objective function) and then "solve the equation" (find the minimum

value of the function) [13]. Among them, the process of finding the minimum value of the function is not limited to artificial neural network, but can be any machine learning algorithm, and the solution process and algorithm implementation of the optimization problem are not the content to be discussed in this paper. This paper will discuss the problem of "setting up equations" or the problem of establishing a mathematical model for the problem. Specifically, it gives the problem of the objective function, and the comparison and correction relationship between the objective function and its optimal solution and the combinatorial category grammar [14].

The deep learning algorithm first finds the objective function and then establishes the problem-solving idea of the objective function, that is, to calculate the conditional probability of one word under the condition of another word. Afterward, judge whether the actual situation of the language in reality is consistent according to the objective function. If not, adjust the value of each word vector in the vocabulary vector table in the objective function, and then judge whether it is better according to the actual situation of the language. So repeatedly, constantly adjust the value of each word vector in the vocabulary vector table in the objective function until it cannot be improved [15].

Zou and Wang [16] use deep learning algorithm to study the color matching problem in web advertising design, which has attracted a large number of customers to visit the website and achieved good results. Sun et al. [17] plan the typesetting problem in web advertising design through combinatorial category algorithm, which gives people a refreshing feeling and promotes the increase of web page visits. Wang et al. [18] design the logo image of web advertising through deep learning algorithm, which achieves the purpose of combining dynamic and static, captures people's attention, and can better transmit information. For the problem of single rhythm and style in web advertising design, Sykers [19] uses deep learning algorithm to design the advertising style in web pages, beautifies the structure of web pages, and reflects the sales characteristics of different businesses.

In general, based on the deep learning algorithm, this paper studies the functional relationship of the deep learning algorithm in detail and then establishes the design model of the deep learning algorithm. Finally, the deep learning algorithm is applied to different businesses' web advertising design styles, compares the impact of different design styles on web advertising, and puts forward corresponding measures to promote the improvement and diversified development of web advertising design styles, which is of positive significance.

2. Establishment of the Deep Learning Algorithm Design Model

2.1. Function Analysis of Deep Learning Algorithm. In the process of deep learning, it is necessary to calculate the characteristics of the learning flow change interval, obtain the flow fluctuation range, and define it as the learning sample of flow change characteristics [20].

In the model space, the flow change interval is defined as QN, which represents the problems encountered in the process of deep learning and represents the range of deep learning, under which the flow change has a relatively stable confidence. Assuming that the confidence of the initial change coefficient of the flow change interval QN is $(1-s)\%$, a and o represent the minimum critical value and the maximum critical value, respectively. The range value corresponding to $(1-s)\%$ belongs to the range of confidence value interval. According to the influence of confidence on the fluctuation interval, it is defined as the interval fluctuation judgment index, and then the interval depth coefficient (Q_{QNVQ}) and interval judgment square root weight (Q_{QNITR}) are obtained, where Q_{QNVQ} represents the accuracy of the depth learning algorithm and Q_{QNITR} represents the uniformity of the deep learning algorithm. The corresponding expressions are

$$Q_{\mathrm{QNVQ}} = \frac{1}{i}\sum_{n=1}^{i} v_n, \tag{1}$$

$$Q_{\mathrm{QNITR}} = \frac{1}{T}\sqrt{\frac{1}{i}\sum_{n=1}^{i}\left(o_n - a_n\right)^2}, \tag{2}$$

where i and T represent the measurement coefficient and peak range of flow interval, respectively.

When the peak value of the measurement interval is within the range of $[a_n, o_n]$, $v_n = 1$. Conversely, $v_n = 0$. When the global measured values belong to this interval, $Q_{\mathrm{QNVQ}} = 100\%$.

In order to avoid the disturbance of the flow outside the interval to the internal flow in the calculation process and improve its accuracy, a balance index (V_{VEV}) is introduced in the calculation process, which represents the balance and reduces the error, and its equation is

$$V_{\mathrm{VEN}} = Q_{\mathrm{QNITE}}\left[1 + \delta\left(Q_{\mathrm{QNVQ}}\right) r^{-Q_{\mathrm{QNVQ}-v}}\right], \tag{3}$$

where v represents the vector coefficient and v is the same as the confidence coefficient, which is defined as $(1-s)$.

Initial determination coefficient of flow interval, $\delta(Q_{\mathrm{QNVQ}}) = 1$, when determining the variation characteristics of the fluctuation range; $\delta(Q_{\mathrm{QNVQ}})$ is a step function, which represents the fluctuation law in the calculation process of the deep learning algorithm and reflects the error of the algorithm; that is

$$\delta\left(Q_{\mathrm{QNVQ}}\right) = \begin{cases} 0, & Q_{\mathrm{QNVQ}} \geq v \\ 1, & Q_{\mathrm{QNVQ}} < v \end{cases} \tag{4}$$

According to the above equation, combined with the equilibrium index V_{VEV}, a characteristic sample value Q_{QNISE} that uniquely satisfies the equilibrium index can be obtained in the defined interval QN, Q_{QNISE} reflects the correlation between the equilibrium index and the step function, which is of great significance, and its expression is

$$Q_{\mathrm{QNISE}} = \frac{1}{iT}\sum_{n=1}^{i}(v_n - a_n). \tag{5}$$

Replace the traffic change characteristic learning samples of the advertising design calculated above into the deep learning algorithm to update the traffic estimation coefficient. The implementation steps are shown in Figure 1. The specific implementation steps are as follows.

2.1.1. Estimation Coefficient Status Confirmation. In the deep learning algorithm, the core learning characteristic coefficients correspond to all traffic estimation states in the space, and the data states to be updated are determined according to the differences between different traffic characteristics and learning characteristic data. Firstly, all traffic packets in the data layer are defined as Q, and the corresponding interaction state traffic node is q_n so that its initial sending point is, the link forwarding node contained in the data receiving end point is, and the network is open. Assuming that the total number of traffic nodes in the traffic packet is I, the total number of node traffic corresponding to single-point transceiver is $I \times I$. If the dimension matrix corresponding to the quantity traffic set is d, the traffic corresponding to its constituent elements can be expressed, and the total traffic from the traffic sending node to the link forwarding node in unit time is

$$d = \begin{bmatrix} f_{11} & f_{1I} \\ f_{I1} & f_{II} \end{bmatrix}. \tag{6}$$

2.1.2. Estimation Coefficient Correction. When confirming the estimation coefficient, the difference between the flow characteristics and the learning characteristic data will cause some errors to the estimation coefficient, which will affect the accuracy of the deep learning algorithm. Therefore, the estimation coefficient needs to be modified. Define the weighted value of the link estimation coefficient corresponding to the traffic n of the adjacent node and the random traffic node k as e_{nk}, and then the weighted coefficient vector corresponding to any traffic node n located at the position of z traffic nodes can be expressed as

$$E_n = (e_{n1}, e_{n2}, \ldots, e_{nz}). \tag{7}$$

If the correction coefficient s is defined as the weighted value set of global flow interaction coefficient $(E_1, E_2, \ldots, E_I)$, the corresponding correction coefficient vector can be described as $s = (E_1, E_2, \ldots, , E_I)$.

2.1.3. Constraint Substitution. According to the above operations, replace the original estimated constraint index with frasu_n, and then

$$t = \sum_{n=1}^{Q}\frac{\mathrm{frasu}_n}{Q}. \tag{8}$$

2.1.4. Estimated Output. The updated network estimation mode is actor network, and the calculation formula of the mean square error of the corresponding traffic transmission estimation is

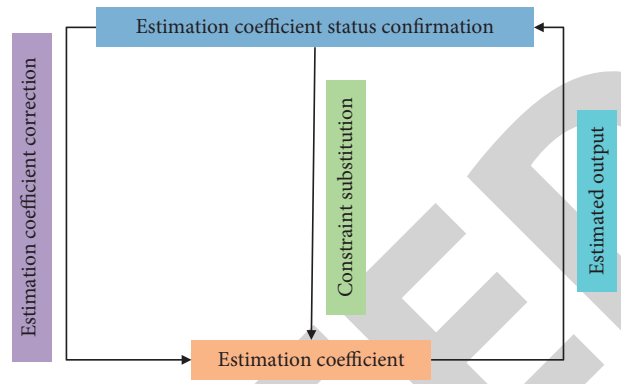

Figure 1: Implementation process of updating advertising traffic estimation coefficient.

$$\mathrm{loss} = \frac{1}{I}\sum_{n}\left[u_n - W(d_n, s_n)\right]^2, \tag{9}$$

where loss is the mean square error of traffic transmission estimation, which reflects the error of depth learning algorithm. I represents the error tolerance of the estimation coefficient, and u_n represents the corresponding value of the output coefficient W of the estimation. Considering the convergence of the estimated output, the gradient normalization calculation method in deep learning is adopted in the estimated output process. It is assumed that there is z associated estimated traffic in node n, and the traffic packet corresponding to effective estimated traffic node n passes through z effective estimated traffic forwarding nodes after data update. The weighting vector corresponding to estimated traffic node n is shown in equation (7). Then, the estimated output formula for estimating the corresponding flow estimation coefficient of node n is

$$Q_{nl} = \frac{1/e_{nl}}{\sum_{k=1}^{z} 1/e_{nk}}. \tag{10}$$

Q_{nl} is the estimated output value corresponding to the estimation node, which represents the estimation rate of the deep learning algorithm, and can better reflect the accuracy advantage of the deep learning algorithm.

Similarly, for different web page designs, the total number of global traffic nodes n passes through z estimated forwarding nodes and the corresponding output formula when the update estimation coefficient is q; that is, the estimation formula after updating the estimation coefficient is

$$Q_{nw} = \frac{1/e_{nw}}{\sum_{k=1}^{i} 1/e_{nk}}. \tag{11}$$

2.2. Deep Learning Algorithm Design Model Construction. Based on the above deep learning algorithm, according to the problem of insufficient attraction in the process of web advertising design, a model of design before construction is

established; that is, the web advertising is investigated and analyzed first, the existing problems are found out, and the deep learning algorithm is used for optimization, so as to obtain the optimized web advertising design style. The specific model diagram based on deep learning algorithm is shown in Figure 2.

3. Experimental Results and Analysis

3.1. Logo Design Analysis. The role of logo for web pages is like a person's business card. Behind the exquisite logo, there must be a professional and exquisite website, which plays the role of the finishing touch. A good commercial web advertising logo will not only show the taste of e-commerce, but also reflect the style and culture of the business. The logo is extremely important for e-commerce web pages. Logo has the effect of identifying and promoting the company in communication. A good logo can make consumers pay attention to the company itself and related web pages. The logo in the network can not only represent a web page, but also represent a module in the web page. At the same time, it can also be used as a graphic sign for the website to link with other websites. When a user enters a web interface for the first time, the e-commerce website logo undoubtedly enters the user's sight first. At this time, if the logo does not attract the viewer's attention, the interface may not leave any impression on the user. On the contrary, if the logo of an e-commerce website is very attractive, people will easily remember the logo and website, which can increase the transaction volume of the e-commerce website. Therefore, as the most important part of e-commerce web design, the website logo should be the most common and important part of the web page. It is not only a combination of pictures and words, but also a standard visual symbol tailored for the website according to the specific web page type and style, after grasping the web page rhythm and considering the type of web page users.

Figure 3 shows the change of attraction value of logo with different advertising designs between web pages over time based on deep learning algorithm. It can be seen that the attraction value of advertising design logos on Taobao and JD.com websites fluctuates up and down with the increase of time, and their change trend is the same, but the attraction value of Taobao logo is high. The attractiveness of the advertising design logo on Alibaba's web page does not change significantly with time, and the fluctuation is small. The attractiveness value of advertising design logo on Meituan's web page was relatively stable in the early stage and then showed a downward trend with the increase of time. The main reason is that the logo design style on the website of each business is different, and the popularity of the public is also different. As we all know, Taobao has the highest usage rate, followed by Jingdong. Therefore, in order to better improve the attractiveness of advertising design on the web page, we should vigorously publicize the business brand, and at the same time, we should also adopt innovative ways to keep up with the needs of customers and keep pace with the times, so as to contribute to the diversification and development of web advertising.

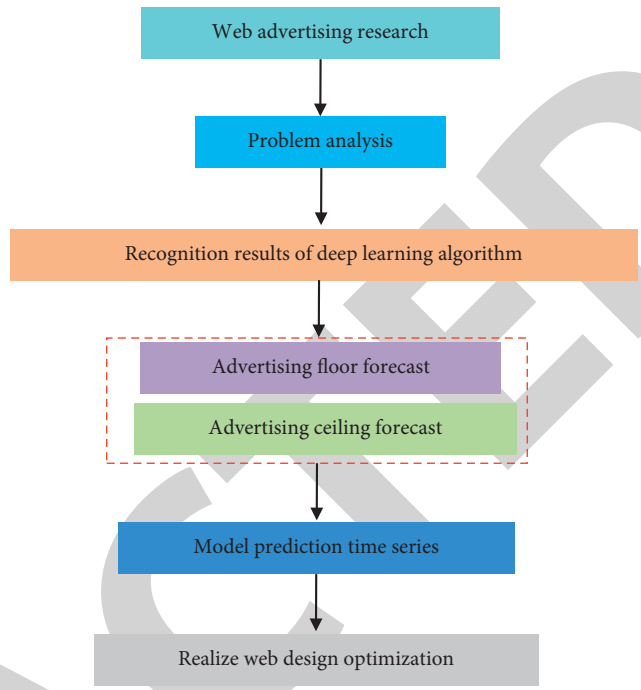

Figure 2: Design model based on deep learning algorithm.

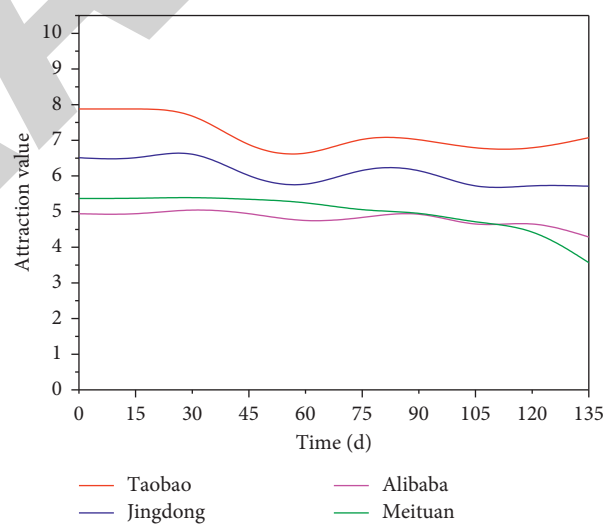

Figure 3: The change of attraction value of logo with different advertising designs between web pages over time based on deep learning algorithm.

3.2. Basic Text Comparison. Although with the maturity of e-commerce and the improvement of Internet technology, there are more abundant elements on web pages, text is still an indispensable carrier. Websites lacking text will not provide users with the most comfortable and convenient feeling. Text can appear anywhere in the e-commerce web interface, whether it is the home page, product introduction, or navigation. The function of text is not only a written language, but also an additional function to convey culture and enhance the aesthetic value of the web interface. As for the main functions of words in e-commerce websites, we not

only need these words to accurately and effectively convey commodity information, but also need to deeply consider the overall visual effect of words, whether they meet the characteristics of e-commerce websites, and whether the appeal of website pages can meet the requirements of visitors. The text in the web page should meet the following requirements: first, the text should be clearly visible and easy to identify. Consumers are looking for simplicity, directness, and convenience through the Internet. A good e-commerce web page will certainly give consumers a clean and convenient initial visual impression. This is achieved by using accurate fonts and font sizes, which will not only be targeted at consumers, but also give the store a comfortable use experience. Larger fonts can be used for e-commerce web page titles. When there are differences in font sizes on the same web page interface, it will increase the vitality of e-commerce web pages and not be too rigid. Secondly, the text in the e-commerce web page must be easy to read. The text layout and layout are very important for the viewer's visual experience. We can design from the line spacing, word spacing, or text arrangement. The loose text layout gives people a relaxed and comfortable visual experience. On the contrary, too compact page layout will make visitors feel too hurried and crowded. For e-commerce websites, shopping is a leisure thing, and visitors do not need to be in a hurry, so they should try to make the text spacing and line spacing not too narrow, so that the page loses its due interest. Finally, the text design in the web page is generally light and heavy. On the premise of not affecting the overall web page style, more appropriately changed text will make the web page interface more rhythmic and vibrant. The same applies to e-commerce web design, such as thickening, framing, underlining, and changing text style to enhance the visual effect.

Figure 4 shows the language proportional rate of different advertising designs between web pages based on deep learning algorithm. Chinese accounts for the highest proportion of advertising design in Taobao website, followed by bilingual composed of Chinese and English. The proportion of English in Jingdong's web advertising design is the highest, followed by Chinese. The advertising design in Alibaba's website is composed of Chinese and English, with bilingual accounting for the highest proportion, followed by Chinese. In Meituan's website, the proportion of bilingual advertising composed of Chinese and English is the highest, and the proportion of English is the lowest. The main reason is that each business has a different popularity and different service objects. Taobao has the highest popularity in China, with Chinese buyers accounting for the vast majority, while JD has a large market abroad, so the use rate of English is the highest. Alibaba and Meituan are well known at home and abroad, so bilingual composed of Chinese and English accounts for the highest proportion, followed by Chinese. Therefore, in order to change the language proportion of different advertising designs between different business web pages, we should according to the domestic and international development of the merchants conduct on-the-spot investigation, seek truth from facts, clarify the service objects of the merchants, keep up with the trend of the times, and adopt a combination of multiple languages to achieve the purpose of web advertising design and publicity, so as to achieve the uniform application of language and the visual development of business.

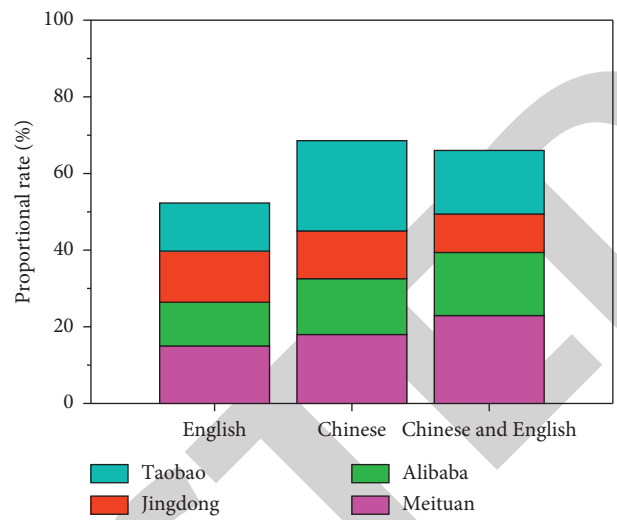

Figure 4: Language proportional rate of different advertising designs between web pages based on deep learning algorithm.

3.3. Label Design. For e-commerce web pages, the name, data, pictures, and other information of goods are presented in a limited space, and the pages should be orderly and concise, which shows the importance of labels. It can shorten the page length without reducing the amount of web interface information and make the information not affect the reading efficiency due to too dense distribution. In the design of e-commerce web pages, vertical labels need to be used instead of multiple rows of horizontal labels, which not only saves space, but also is relatively beautiful; if there is a structural relationship between label contents, labels can be grouped in the design, and menus can be designed as drop-down menus or color groups in different groups; if there are differences in the importance or relevance of labels, you can mainly display the most important labels and then add the "other more" option; if the label contents of e-commerce web pages are at the same level, the design can be improved from the perspective of the label bar, such as adding left and right mobile buttons to allow users to slide or drag with the mouse. The label is divided into two parts, the label area and the content area. Labels are divided into selected labels and unselected labels. Generally, the color of selected labels is clearly distinguished from the background color of unselected labels, with high discrimination. There should be a specific connection between the title words in the label area. There should be no contrast or parallel relationship between the information. The title words should also be short and concise. The content area is an overlapping area. The content of each layer is displayed alternately, which not only arranges the information, but also displays a large amount of content in a limited space. The information can be presented in words or signs as shown in the figure below, but the layout must be neat and uniform.

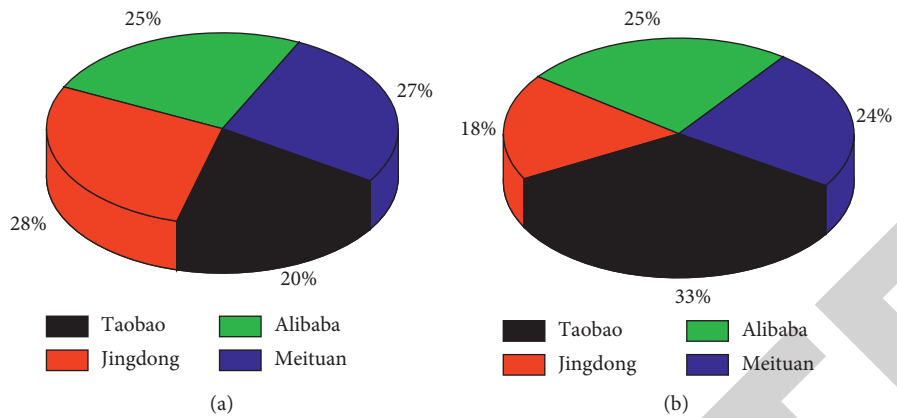

Figure 5: Design of different labels between web pages based on deep learning algorithm. (a) Vertical label. (b) Horizontal label.

Design of different labels between web pages based on deep learning algorithm is shown in Figure 5. It can be seen that for vertical labels, JD and Meituan have similar proportions of web page vertical label design, ranking in the top two, while Taobao has the lowest proportion of vertical labels in web page advertising design. On the contrary, Taobao mainly uses horizontal labels in web advertising design, followed by Alibaba and Meituan, and finally Jingdong. The main reason may be the difference in the popularity of businesses and people's habits. Taobao is the largest online shopping platform in China. People tend to browse. With horizontal labels, it is easy to read. Therefore, there are differences in labels in web advertising design of different businesses.

3.4. Multilevel Navigation Design Style. Web navigation refers to the use of specific scientific and technological methods to establish a path for web visitors, so that they can more intuitively and concisely find the content or items they want. The early navigation menu basically adopts the horizontal top display, and the sidebar menu will be a new trend this year. Navigation has a long application history. At first, it is only applied to computer applications and then gradually applied to social media websites. Web page navigation is based on the structure of web page columns to provide users with necessary operation and information prompt system. There are three kinds of web navigation: primary navigation, secondary navigation, and bread crumb navigation. The main navigation is usually used at the top of the page header or below the banner, which can easily guide customers to quickly find the information area. The secondary navigation is usually located on both sides of the website. When customers need to enter different columns of the same level, they can quickly enter through the secondary navigation. Bread crumb navigation is a navigation about location. Its function is to make customers know their specific location subjectively. It is a navigation type that displays the detailed location of visitors in the website or network application.

Top horizontal bar navigation is a popular design type of website navigation nowadays. It is generally seen in the main navigation design of web pages and mostly exists above or below the web logo at the top of the page. For e-commerce websites with too complicated information, this navigation is the most common, because it can make users operate more easily and comfortably. There are several forms of secondary navigation, such as drawer navigation. By default, the navigation menu is not displayed at all. It will be opened only when the mouse touches the specified icon. When the mouse slides over one of the columns, the content of its second layer will continue to expand, providing users with a clear operation path. This navigation is the most suitable for e-commerce web pages, which not only saves the already tight and limited web space, but also points out the operation path to users.

The simulation value of design style of web page navigation based on deep learning algorithm is shown in Figure 6. It can be seen that the navigation in the web advertising design of different businesses is different, but the simulation value of bread crumb navigation is the largest and the simulation value of main navigation is the lowest. The largest changes in navigation in web advertising design are Taobao, Jingdong, Alibaba, and Meituan from high to low. Therefore, when designing a different web advertising, we should fully consider the navigation popularity of each business. In addition, several principles should be followed: first, try to use primary classification to make users more aware of information. The current category in the main navigation should be highlighted. Secondly, in the navigation design, try to reduce the difficulty of mouse operation. Finally, what we need to do is to inform the customer of the current location; that is, it is time to talk about our bread crumb navigation design. The biggest advantage of bread crumb navigation is to help customers identify and judge the best scheme of their current position, so its design must be easy to identify. Then, we can start from the color of text, the thickness of font, the size of font, and so on, which is greatly different from other text in the web page. Only by adjusting measures to local conditions and adopting different navigation design methods according to different businesses, can we better promote the diversified development of web design.

3.5. Customer Satisfaction Survey. The existence of web forms is necessary, but in actual operation, it is often a weakness for designers and customers. With the

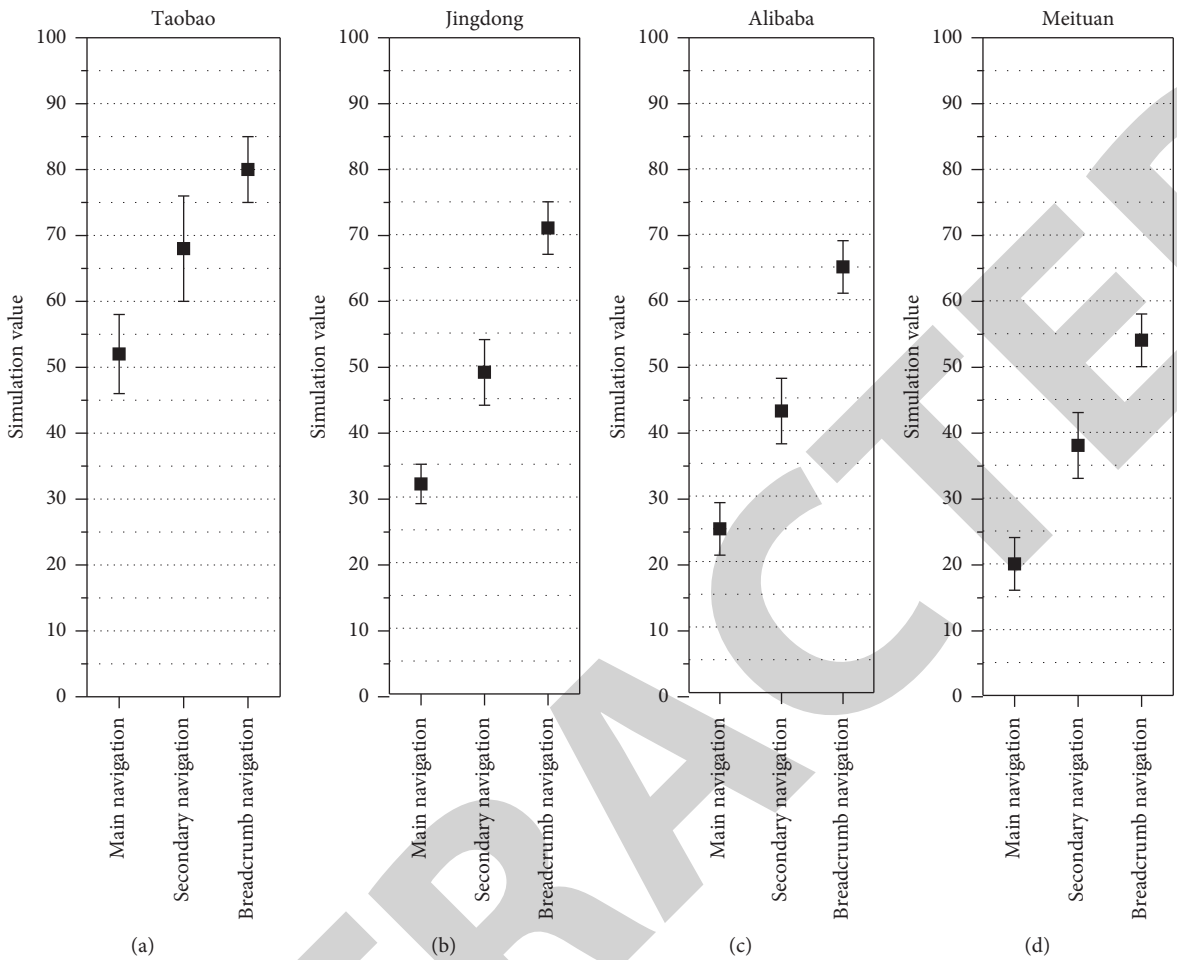

Figure 6: Simulation value of design style of web page navigation based on deep learning algorithm. (a) Taobao. (b) Jingdong. (c) Alibaba. (d) Meituan.

development of society and the passage of time, users' expectations and rigid needs are getting higher and higher. What style should the form look like and how to run. Some people say that web design is a combination of modern art and technology. In the process of design, first look at whether the color of the whole page is coordinated or not, and whether it gives people a bad feeling; secondly, we need to see whether the text shape design on the web page is convenient for users, look at the size and number of pictures in the web page again, and whether the interaction function is perfect; finally, look at the dynamic and static collocation of web pages. Not using dynamic effects will make the web interface lifeless. On the contrary, excessive use will make people dazzling and aesthetic fatigue.

Figure 7 shows the satisfaction rate of web advertising design based on deep learning algorithm. It can be seen from this that the satisfaction rate of people with web advertising design of different businesses varies little, ranging from 65% to 85%. Among them, people have the highest satisfaction with the advertising design of Taobao web page, followed by Jingdong web page, and Alibaba web page has the lowest satisfaction with the advertising design. However, although the advertising design satisfaction rate of Meituan's website is higher than the average of Alibaba's website, people's satisfaction rate is relatively scattered, which needs attention and improvement. In general, the deep learning algorithm can predict and analyze the web advertising design of

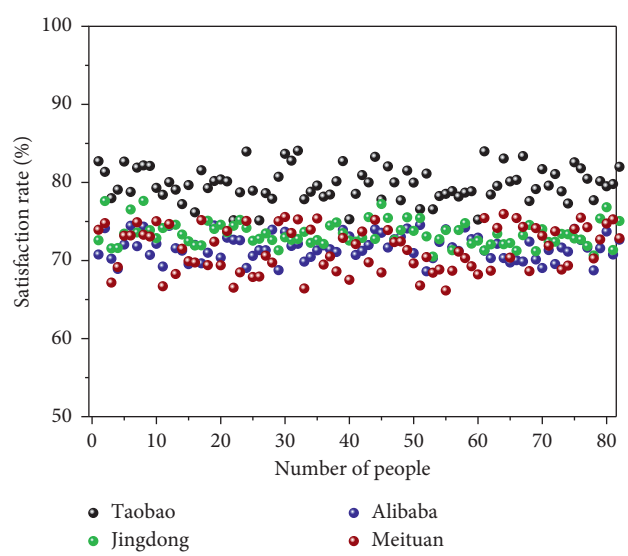

Figure 7: Satisfaction rate of web advertising design based on deep learning algorithm.

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Retraction

Retracted: Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] B. Tian, Z. Xie, and W. Peng, "Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System," *Security and Communication Networks*, vol. 2022, Article ID 8999757, 9 pages, 2022.

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Research Article

Application Analysis of Multi-Intelligence Optimization Decision-Making Method in College Students' Ideological and Political Education System

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Today's society is a society with diversified information. The rapid change of information also affects the ideological and political education in universities. Therefore, the fixed thinking of ideological and political education in universities tells students, which is an educational way in line with the development of the times. We should follow up with the rapidly changing times at any time, change with the times, and update the thinking and systematic way of the ideological and political education system at any time. In the ideological and political education of college students, diversified teaching methods and multiobjective recommendation systems are implemented and then combined with traditional ideological and political teaching methods. The two ways complement each other and promote each other so as to achieve higher learning efficiency and better learning effect. The optimization algorithm of multiobjective recommendation should be used to further improve the ideological and political education system. By analyzing the optimization results and performance comparison of various algorithms, we find the most suitable algorithm model for optimizing the ideological and political education system. The multiobjective-recommended ideological and political education system for college students needs to fully improve the teaching tasks of teachers and students in two stages. A reasonable and scientific system recommendation mechanism should take into account students' own learning preferences, subject types, ideological and political teacher information, curriculum information, curriculum evaluation, curriculum relevance, and other multiobjective data. This paper achieves the highest performance and the lowest time cost of the ideological and political education system through multiobjective evolutionary optimization method.

1. Introduction

Under the new social background and the environment of network development, the extreme imbalance of social development leads to an insufficient imbalance of human development, which makes how to make people develop in a balanced way become the focus of this era. As a course of ideological and political education guiding people's ideological development, people's balanced development guides a new direction and injects new blood into its reform in this era. Lon et al. [1] verified the application of this algorithm through a case study of a numerical high road construction project and proves its ability to generate nondominated solutions. Compared with the nondominated sorting genetic algorithm (NSGA-II), multiobjective particle swarm optimization (MOPSO), multiobjective differential evolution (MODE), and previous results, it verifies the efficiency and effectiveness of the proposed algorithm. A multiobjective mixed-integer linear programming (MOMILP) model is proposed in [2], which is used to assign a group of flights to different runways and determine their actual arrival and departure times. Chattopadhyay and Banerjee [3] compare the performance of the heuristic method with that of the optimal method, and through experiments on WSC-2009 and ICEBE-2005 data sets, they show the effectiveness of our proposal compared with other classical methods for the same problem setting [4]. These pre-Pareto solutions of MOP have various characteristics, such as convex,

nonconvex, and discrete, and can also be used to solve multiobjective design applications with unique functions. In the stratified random survey for multispecies abundance index estimation in reference [5], the differences and seasonal changes in the stratigraphic abundance of different species should be comprehensively considered in the sampling work distribution of each stratum. Fang et al. [6] realize multiobjective and ultrahigh reliability control scheme, which is suitable for LCL grid-connected inverter systems with input series output parallel connection. Stanojevic et al. [7] introduce two clear linear models to solve the fuzzy multiobjective linear fractional programming problem. Niquepa et al. [8] propose a fuzzy multiobjective optimization method for planning independent power generation systems. Obloj and Sengul [9] show that multiple goals can bring costs to organizations, but it also provides benefits to reduce the trade-off of achieving higher performance in multiple dimensions. Lin et al. [10] use fast SoRting strategy (FSR) and prelarge concepts to find optimal deletion transactions and speed up the iterative process. In the developed NSGA2DT, several sets of Pareto solutions can be easily found, thus avoiding the local optimization problem of the single-objective method. Ciripoi et al. [11] use multiobjective linear programming to solve the polyhedral projection problem. Hahn et al. [12] prove that the multiobjective synthesis problem is PSPACE-hard and provides a decision-making algorithm based on value iteration to approximate the Pareto set of realizable points. Huang et al. [13] modeled the feature selection process as a multiobjective optimization problem in order to obtain the optimal number of selected features reasonably and automatically. Zaman and Shehu [14] balance multiple targets in conformational sampling to control bait diversity in template-free protein structure prediction. Mohammed et al. [15] optimize multiple conflicting goals through controlled and directional morphological changes in urban structure. Prayogo and Kusuma [16] studied the optimization of resource balance problems under a multiobjective standard based on symbiotic organism search. In reference [17], the effectiveness of the proposed method is explained by taking the industrial case study of a two-way nonbackward drivable roller clutch as an industrial case, and the results are compared and discussed and verified. Lovison and Miettinen [18] propose an accurate and as realistic direct method for multiple objectives, provides proof of global convergence and tests the efficiency of the algorithm on nonlinear and non-convex vector functions. The multiobjective model developed in reference [19] can meet the operational production requirements of a fleet using 85% of the required fleet size of the deterministic calculation. Habibe and Fatemeh [20] introduces the multiobjective programming method of linear bilevel multifollower programming. Duc and Luong [21] propose an effective and efficient adaptive multiobjective algorithm called AMODE, which is used to optimize the schedule by considering time, cost, and risk at the same time. The spiral model provided in the literature [22] shows the continuity of content and overcomes the gap in programming knowledge between high school and higher education. Iva et al. [23] emphasize the importance of reducing educational inequalities and the desirability of improving access to higher education, expanding access to complete education later in life and promoting and supporting lifelong learning. Sabuncuoglu and Halayqeh [24] investigated EFL learners' views on learner autonomy and the extent to which their views on their responsibilities, abilities, motivation, and their activities and behaviors in and out of the classroom are actually applied. Parkes et al. [25] state that universities must resist the assumption that the "problem" of student retention rate and performance can be solved only by numbers and algorithms; rather, the work in Los Angeles must be based on a reconnection with agreed values related to the purposes of higher education, including democratic participation, recognition of diversity and personal experience, and the process of becoming.

2. Current Situation of Ideological and Political Education at Home and Abroad

2.1. Attach Importance to Ideological and Political Education in China. People's ideas are always influenced by living environment, social status, national beliefs, and cultural traditions. Pure education of cultural knowledge and scientific and technological knowledge is not enough to make people establish a correct idea. Many scholars and experts still have different ideas and opinions on the internal significance of the ideological and political education environment. At present, there are mainly the following three concepts: first, the environment of ideological and political education refers to the sum of all non-self-factors that have an impact on the formation and development of ideological and political education activities and the ideological and moral character of ideological and political education objects. On the one hand, concept 2 refers to the total environment of all external factors that lead to ideological and political education and changes in people's ideological and moral character. On the other hand, it refers to the environment as an educational factor in the process of educational activities. The ideological and political education environment here includes both spontaneous ideological and political education environment and conscious environment of the educated's activities, which is constructed according to the ideas, requirements, and purposes of the impactors. From the living environment, social environment, and learning environment, in-depth analysis of the macroenvironment on the ideological impact of college students is performed. From five aspects such as family environment, school environment, social organization environment, community environment, and peer environment, this paper discusses the influence of microenvironment on ideological and political education. The contemporary college students' environment and network environment bring new blood to the ideological and political education system of college students. This paper explores and updates the effective ways and methods to enhance the ideological and political education of college students in the computer age from the aspects of network age construction, educational culture construction, family self-construction, and college students' self-quality. Scholars put forward different opinions on the optimization of the

environmental system in which college students' ideological and political education is located, which has positive guiding significance for educators and educatees to optimize and update the system together and expand the rich system.

2.2. Attach Importance to Ideological and Political Education Abroad. Foreign countries have not put forward the concept of "ideological and political education," but quietly carry out ideological and political education under the banner of "moral education, religious education, history education," so there are very few research results on improving their own ideological education environment. Foreign scholars' research on the educational environment in which education is really located mainly focuses on two aspects: on the one hand, the influence of environment on people; on the other hand, the influence of environment on education. Piaget's epistemology and Bandura's interactive determinism are the most representative ones in the discussion of the relationship between environment and human beings. Piaget pointed out in "Principles of Genetic Epistemology" that biological development is an interactive process of two behaviors: individual living environment and how to adapt to the environment. He emphasizes the relationship and function between subject and object, and this interaction is regulated by individual willpower. Bandura emphasizes that while the environment transforms people, people can also react to the environment in the theory of interactive deterministic relationship. Thus, Bandura's interactive learning theory not only shows that the environment can transform people but also shows that you should pay more attention to your own willpower.

2.3. System Structure of Ideological and Political Education for College Students. According to the system theory, every system has its own internal structure. "Structure refers to the relatively stable contact mode, organizational order, and the internal manifestation of its time-space relationship among the various components of the system." The structure of the environment in which college students learn ideological and political education refers to the mutual influence of the major factors in the system, which is the structured social existence of its internal elements and reflects the interrelation and mutual restriction of the elements in the system. The systematic result of the learning environment in which the educated live is not to make a simple set of each element variable of the system, it is a structural organic unity formed by entering the relationship of elements. College students are in the environment of ideological and political education, and the specific relationship and order among the major elements constitute the systematic structure of the ideological and political environment for the educated to learn themselves. Every system has its internal structure, and its internal structure can be regarded as a system. College students should understand the basic structural levels of their own environment for learning education and their interrelationships, and know what important guiding significance it has for optimizing the system. The environment structure is shown in Figure 1:

3. Correlation Algorithm

3.1. Multiobjective Evolutionary Algorithm of Ideological and Political System

(1) The initialization stage is similar to the genetic algorithm. In the MOTLBO algorithm, a population is a class, and every student in the class is randomly generated in the feasible region of decision variables. Then, the initial class group $x^0_{(i,j)}$ can be expressed as

$$x^0_{(i,j)} = x_j^{\min} + \text{rand} \times \left(x_j^{\max} - x_j^{\min}\right). \tag{1}$$

The ideological and political scores of the first student after g iterations are

$$x_i^g = \left[x^g_{(i,1)}, x^g_{(i,2)}, \ldots, x^g_{(i,D)}\right]. \tag{2}$$

Objective function:

$$\begin{bmatrix} Y^g_{a,i} \\ Y^g_{b,i} \end{bmatrix} = \begin{bmatrix} f_a\left(X_i^g\right) \\ f_b\left(X_i^g\right) \end{bmatrix}. \tag{3}$$

(2) The teaching stage of ideological and political teachers.

Average achievement:

$$M^g = \left[m_1^g, m_2^g, \ldots, m\right]. \tag{4}$$

System update in the teacher stage:

$$X^g_{\text{new},i} = X^g_{\text{old},i} + \text{rand} \times \left(X^g_{\text{teacher}} - TF \times M^g\right). \tag{5}$$

Learning mechanism of students in the learning stage:

$$X^g_{\text{new},i}|a = \begin{cases} X^g_{\text{old},i} + \text{rand} \times \left(X_i^g - X_h^g\right), & \text{if}\left(Y^g_{a,i} < Y^g_{a,h}\right), \\ X^g_{\text{old},i} + \text{rand} \times \left(X_h^g - X_i^g\right), & \text{otherwise}, \end{cases}$$
$$X^g_{\text{new},i}|b = \begin{cases} X^g_{\text{old},i} + \text{rand} \times \left(X_i^g - X_h^g\right), & \text{if}\left(Y^g_{b,i} < Y^g_{b,h}\right), \\ X^g_{\text{old},i} + \text{rand} \times \left(X_h^g - X_i^g\right), & \text{otherwise}. \end{cases} \tag{6}$$

3.2. Multiobjective Simulated Annealing Algorithm for Ideological and Political System. Objective function:

$$\min f_1\left(y_j^m\right) = \left(\frac{f_3\left(y_j^m\right)}{f_3(\partial)}\right),$$
$$\min f_2\left(y_j^m\right) = \left(\frac{f_2(\partial)}{f_2\left(y_j^m\right)}\right), \tag{7}$$
$$\min f_3\left(y_j^m\right) = \left(\frac{f_3\left(y_j^m\right)}{f_3(\partial)}\right).$$

Multiobjective initial solution:

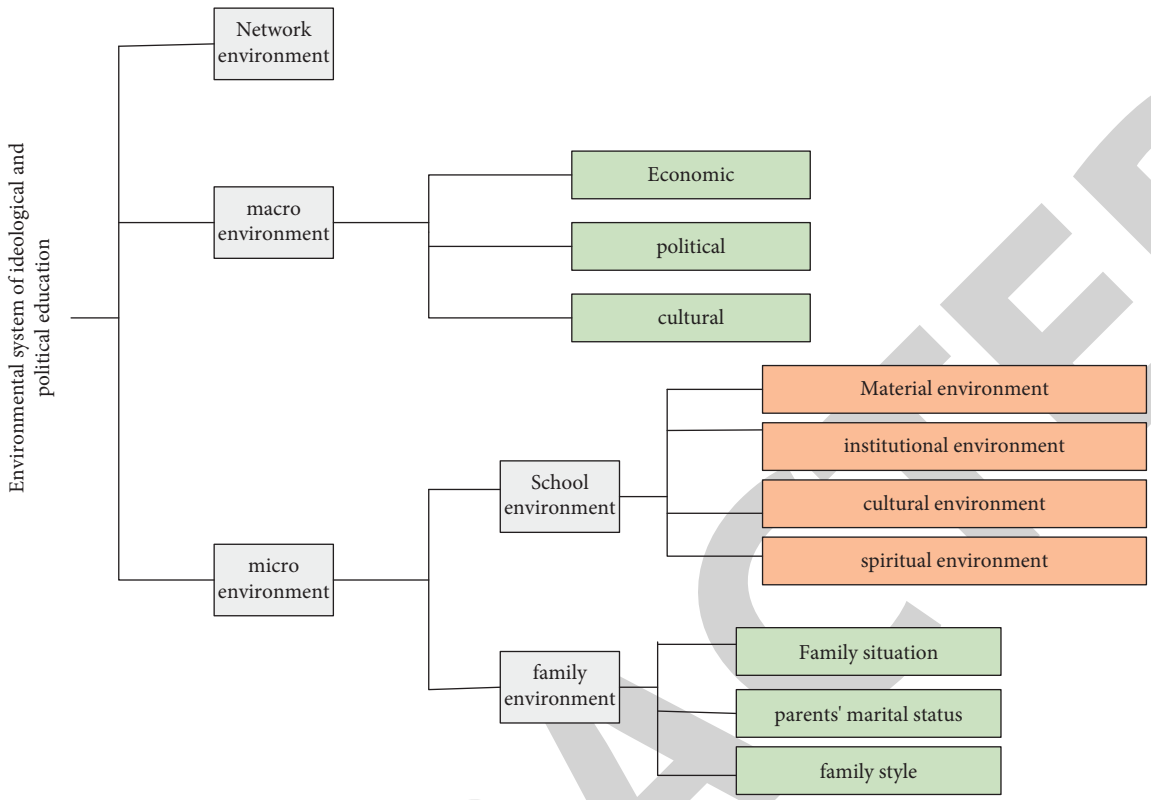

Figure 1: Environment structure.

$$\min f = \omega_1 * f_1\left(y_j^m\right) - \omega_2 * f_2\left(y_j^m\right) + \omega_3 * f_3\left(y_j^m\right). \quad (8)$$

Take the largest subtarget for annealing, expressed by $f(y)$:

$$f(y) = \max\left\{f_1(y_i), \left|f_2(y_i)\right|, f_3(y_i)\right\}. \quad (9)$$

Update variables:

$$y_{i+1} = y_i - \eta + 2 * \eta * \text{rand}. \quad (10)$$

3.3. Multiobjective Ant Colony Optimization Algorithm for Ideological and Political System. The moving formula of students' liking for ideological and political courses is as follows:

$$j = \arg\max\left\{\left[\tau_{ij}(t)\right]\left[\eta_{ij}^1(t)\right]\left[\eta_{ij}^2(t)\right]^{(1-\lambda)\beta}\right]\right\}. \quad (11)$$

Probability of degree change:

$$p_{ij}^k t = \frac{\left[\tau_{ij}(t)\right]\left[\eta_{ij}^1(t)\right]\left[\eta_{ij}^2(t)\right]^{(1-\lambda)\beta}\right]}{\sum\limits_{s\in allowed}\left[\tau_{is}(t)\right]\left[\eta_{is}^1(t)\right]\left[\eta_{is}^2(t)\right]^{(1-\lambda)\beta}\right]}. \quad (12)$$

Information update:

$$\tau_{ij} = (1-\rho)\cdot\tau_{ij} + \rho\cdot\tau_0. \quad (13)$$

Global update:

$$\tau_{ij} = (1-\rho)\cdot\tau_{ij} + \frac{\rho}{\left(Z_1(S)\cdot Z_2(S)\right)}. \quad (14)$$

3.4. Multiobjective Particle Swarm Optimization Algorithm for Ideological and Political System. Normalization function:

$$f'(x) = \left(\frac{f(x) - f_{\min}}{f_{\max} - f_{\min}}\right) - \sin\left(2\pi\frac{f(x) - f_{\min}}{f_{\max} - f_{\min}}\right). \quad (15)$$

The evaluation function is obtained:

$$Fp_{pri}\ ,\ p_{pri} = \omega_1 M'\left(p_{pri}, p_{\sec}\right) + \omega_2 MIRR'\left(p_{pri}, p_{\sec}\right) + \left[-\omega_3 S'\left(p_{pri}, p_{\sec}\right)\right]. \quad (16)$$

Location update:

$$\text{Position}_{i+1} = \text{position}_i + v_i. \quad (17)$$

3.5. Constraints of Multiobjective Algorithm.

$$\begin{cases} \min f = F(x) = \left(f_1 x, f_2 x, \ldots, f_M x\right)^T, \\ s.t, g_i x \geq 0 \quad i = 1, 2, \ldots, q, \\ h_j(x) = 0 \quad j = 1, 2, \ldots, p. \end{cases} \quad (18)$$

Introducing the penalty factor, the original problem is

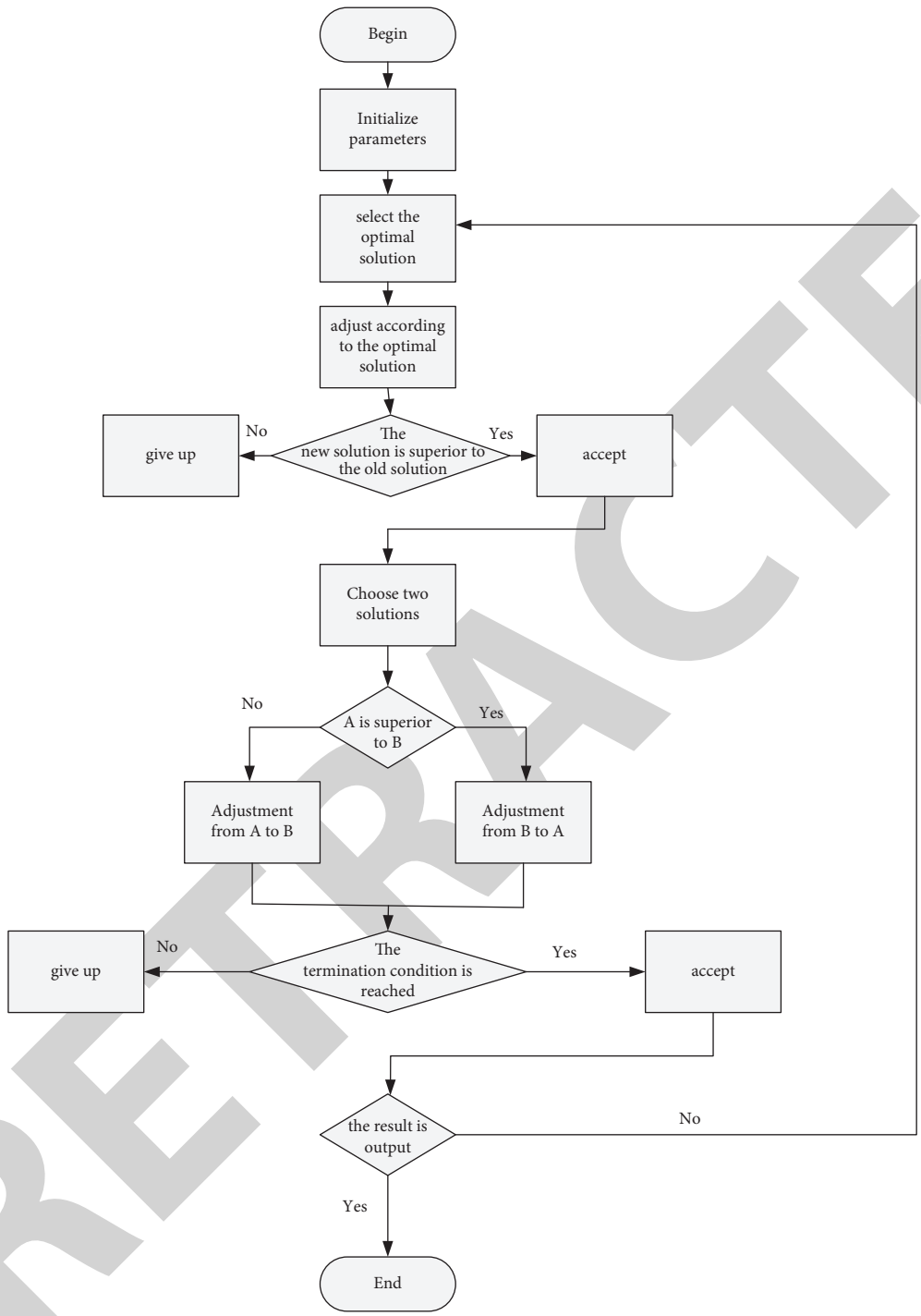

Figure 2: Algorithm flow.

$$\min T(x,\sigma) = F(x) + \sigma P(x). \tag{19}$$

The penalty function is

$$P(x) = \sum_{i=1}^{q} \varnothing(g_i x) + \sum_{j=1}^{p} \varphi\left(h_j(x)\right). \tag{20}$$

Functions $\varnothing$ and φ satisfy the following continuous function:

$$\varnothing(g_i x) = \begin{cases} 0, g_i x \geq 0, \\ \left[\max\{0, g_i x\}\right]^2 g_i x < 0 \end{cases} \left(\omega_1 + \omega_2 + \omega_3 = 1\right).$$

$$\varphi\left(h_j(x)\right) = \begin{cases} 0, h_j x = 0, \\ \left[h_j x\right]^2 h_j x \neq 0. \end{cases} \tag{21}$$

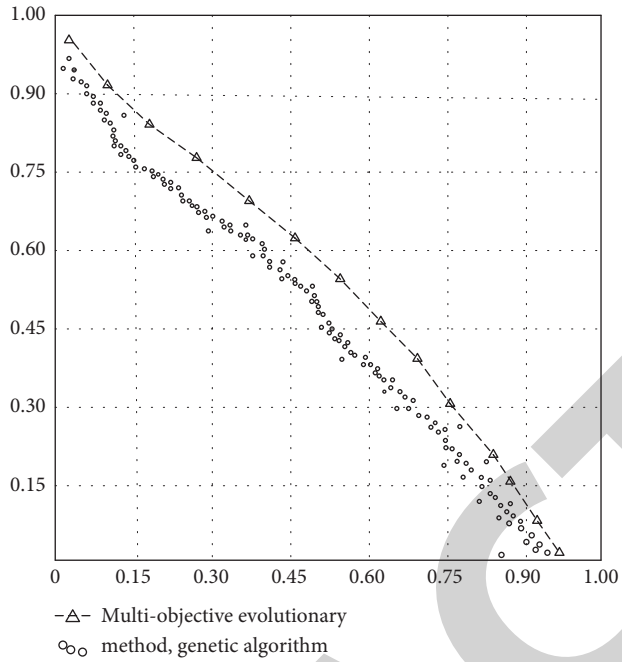

Figure 3: Result distribution map.

4. Experiment

According to the MOTLBO algorithm, the environmental system for educators to teach ideological and political courses is optimized at the teacher stage and the student stage respectively. The process is shown in Figure 2.

4.1. Simulation Experiment. The initial conditions are set as follows: set the population size to 100, and test the distribution of the results of the multiobjective evolution method and ant colony algorithm when dealing with constraints, as shown in Figure 3:

The results obtained by these two methods are tested, and the result distribution of the genetic algorithm is more dispersed than that of the multiobjective evolutionary method. The formula is as follows:

$$S - \sqrt{\frac{1}{|p|-1}\sum_{i=1}^{|p|}\left(\bar{d}-d_i\right)^2},$$
$$GD^*\left(P,P^*\right) = \frac{\sqrt{\sum_{v\in P} \mathrm{d}\left(v,P^*\right)}}{|P|}. \tag{22}$$

According to the evaluation index of the multiobjective optimization algorithm, three samples are selected to further evaluate the performance of the two algorithms, and the running time, convergence index, and distribution index of the algorithms are calculated. In order to avoid randomness, each algorithm is run independently 10 times according to the same initial conditions, and the mean value and variance of 10 runs are counted. The data results are shown in Table 1.

From the data in the table, we can know that the system of ideological education for imparters uses the multi-objective evolution method to run less time than the genetic algorithm, and its convergence and distribution are also better than the genetic algorithm.

4.2. Model Comparison. Considering the comparison of recommendation accuracy, recommendation recall, F value, and AUC value of four multiobjective algorithm models in recommending ideological and political education, the recommendation performance of the fusion model is verified as follows.

The accuracy of the four algorithm models is compared with different recommended numbers, as shown in Table 2:

The statistics data in the above table is given in a bar chart, as shown in Figure 4.

The ideological and political education system conducts recall rate pairs for four algorithm models at different recommended quantities, as shown in Table 3:

The statistics data in the above table is given in a bar chart, as shown in Figure 5.

Pair the F values of the four algorithm models at different recommended quantities, as shown in Table 4.

The statistics data in the above table is given in a bar chart, as shown in Figure 6:

AUC value pairs are performed for the four algorithm models at different recommended quantities, as shown in Table 5.

The statistics data in the above table is given in a bar chart, as shown in Figure 7:

It can be seen from the chart of model comparison that the accuracy, recall, F value, and AUC value of the multi-objective evolution model are always higher than those of the

Table 1: Experimental data.

Algorithms	Performance parameters	Multiobjective evolutionary method		Genetic algorithm	
		Mean value	Standard deviation	Mean value	Standard deviation
Sample1	Runtime	15.012	12.014	10.011	9.031
	Convergence	2.352	3.669	5.769	4.569
	Distribution	8.341	6.342	5.342	4.352
Sample2	Runtime	15.323	14.582	9.982	9.082
	Convergence	2.713	2.431	6.451	4.411
	Distribution	9.584	5.439	5.439	4.519
Sample3	Runtime	15.37	14.111	10.111	9.812
	Convergence	2.936	2.618	5.628	4.128
	Distribution	3.753	2.192	1.142	0.998

Table 2: Data comparison table.

Model	Quantity						
	10	20	30	40	50	60	70
Evolutionary algorithm	0.41	0.39	0.38	0.38	0.39	0.37	0.37
Genetic algorithm	0.29	0.26	0.24	0.26	0.25	0.27	0.21
Simulated annealing algorithm	0.31	0.24	0.25	0.27	0.28	0.22	0.24
Particle swarm optimization algorithm	0.33	0.22	0.25	0.28	0.25	0.23	0.23

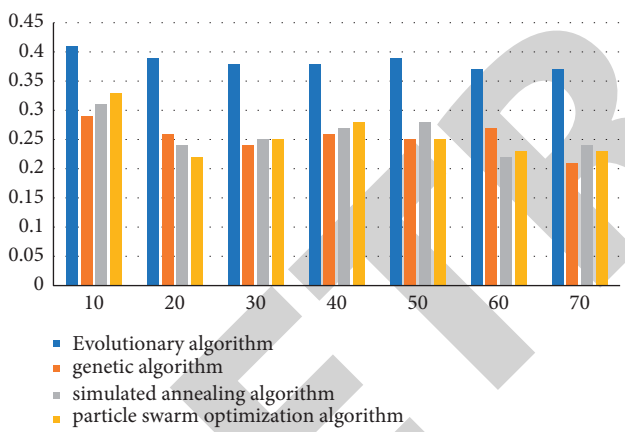

Figure 4: Comparison of the algorithm accuracy.

Table 3: Data comparison table.

Model	Quantity						
	10	20	30	40	50	60	70
Evolutionary algorithm	0.21	0.29	0.33	0.38	0.45	0.47	0.49
Genetic algorithm	0.12	0.16	0.20	0.26	0.31	0.33	0.35
Simulated annealing algorithm	0.14	0.15	0.25	0.27	0.28	0.32	0.34
Particle swarm optimization algorithm	0.13	0.16	0.25	0.28	0.30	0.33	0.36

other three algorithm models when the number of recommendations is different.

4.3. Contrast Experiment. There is an exponential relationship between the attenuation factor and the test times of the solution, and the search step will decrease with the

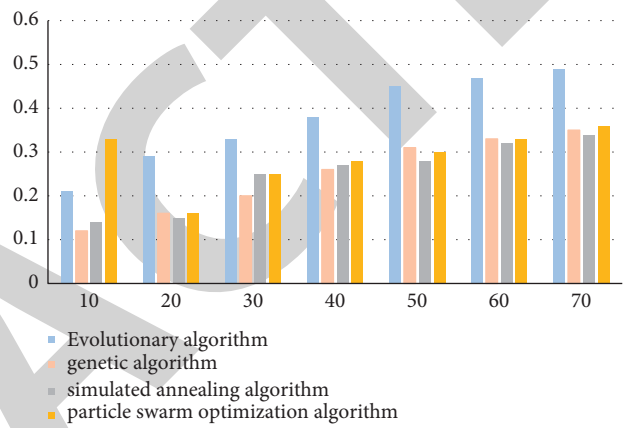

Figure 5: Comparison chart of algorithm recall rate.

Table 4: Data comparison table.

Model	Quantity						
	10	20	30	40	50	60	70
Evolutionary algorithm	0.171	0.239	0.353	0.381	0.451	0.472	0.491
Genetic algorithm	0.121	0.216	0.260	0.262	0.311	0.334	0.353
Simulated annealing algorithm	0.142	0.195	0.253	0.271	0.282	0.324	0.344
Particle swarm optimization algorithm	0.132	0.196	0.256	0.268	0.302	0.336	0.365

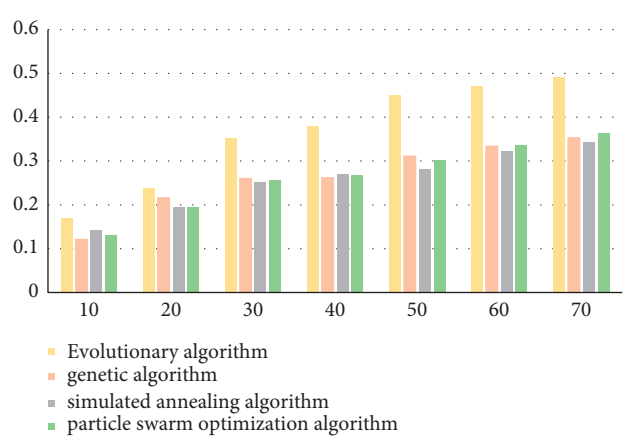

Figure 6: Comparison diagram of algorithm F value.

Table 5: Data comparison table.

Model	Quantity						
	10	20	30	40	50	60	70
Evolutionary algorithm	0.271	0.339	0.453	0.581	0.651	0.772	0.891
Genetic algorithm	0.221	0.316	0.360	0.462	0.511	0.634	0.753
Simulated annealing algorithm	0.242	0.295	0.353	0.471	0.482	0.524	0.644
Particle swarm optimization algorithm	0.232	0.296	0.356	0.468	0.502	0.636	0.735

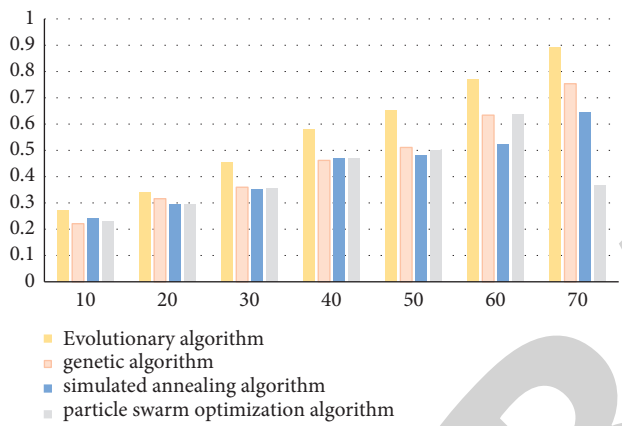

Figure 7: Comparison of AUC values of algorithms.

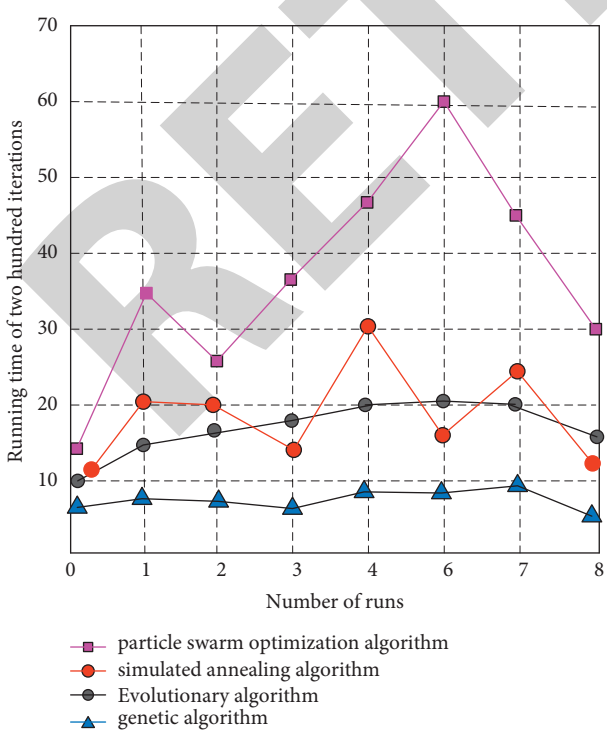

Figure 8: Comparative performance chart.

increase of algebra. If the attenuation factor is selected too large, the convergence speed of the algorithm will be reduced, and the performance of the algorithm will also be affected. We compare the performance of different algorithms, as shown in Figure 8.

5. Conclusion

The core of ideological education for college students is to deeply shape students' psychology and spirit, which is very critical for students' life. In college teaching, we should not only pay attention to the teaching of specialized courses but also pay attention to the important role of ideological politics in the formation of people's three views. Dare to innovate and reform, and constantly optimize the ideological and political teaching system in colleges and universities, not only to follow the law of the formation and development of college students' ideological and moral character but also to innovate and reform constantly so as to fundamentally improve the scientific and effective educational environment of colleges and universities, respect the dominant position of college students, and serve the healthy growth of college students. By comparing various recommendation algorithms, this paper draws the following conclusions:

(1) In the data table of recall rate and F value for the four algorithms, the more the number of recommendations, the greater the recall rate and F value, which is more practical.

(2) In the comparative experiment, the genetic algorithm and multiobjective evolutionary algorithm are the most stable among the four algorithm models due to the interference of the attenuation factor, but the performance of the multiobjective evolutionary algorithm is higher.

(3) Compared with the genetic algorithm, the results obtained by the multiobjective evolution method are more aggregated in convergence and distribution and have better performance.

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 declare that they have no conflicts of interest regarding this work.

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Retraction

Retracted: Analysis of University Education Management Based on Artificial Intelligence

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Zhu, "Analysis of University Education Management Based on Artificial Intelligence," *Security and Communication Networks*, vol. 2022, Article ID 8132523, 11 pages, 2022.

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Research Article

Analysis of University Education Management Based on Artificial Intelligence

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With the rapid development of information technology, the process of informatization of education management has been accelerated. In this context, more and more education management information systems have been used in education management, providing a lot of data support for education decision-making. In addition, the development of artificial intelligence has greatly changed the way people work and live. Intelligence has emerged in various fields, bringing great convenience to people, especially the university education management. This study will integrate artificial intelligence and university classroom teaching and apply it in the field of education management. In particular, the proposed intelligent education management system mainly includes three submodules: preclass attendance, in-class state monitoring, and after-class online learning. The main function of the preclass attendance module is that half an hour before the class starts, the camera captures students' video information and sends it back to the convolutional neural network (CNN) model for face recognition processing. In class, the state detection module is mainly based on face recognition to judge the state of students. The after-class module analyzes the evaluation information of students' online learning to provide a teaching reference for the school. The system proposed in this study can improve the quality of students' classroom learning and teachers' monitoring of the quality of students' classroom.

1. Introduction

1.1. The Research Background. Influenced by the society's strong demand for higher education and driven by the trend of higher education reform, the basic characteristics of higher education in the 21st century have been increasingly clearly displayed in front of people. These characteristics can be summarized as follows: 1. higher education will develop into universal education. 2. Higher education has evolved into lifelong education. 3. Higher education is increasingly diversified. 4. Higher education units will enjoy greater autonomy. In recent years, the combination of artificial intelligence and education has gradually entered universities and educational institutions [1]. With the development of information and network technologies, information becomes ubiquitous and fills every corner of the world. Today's society is in an era of knowledge explosion and massive information. Faced with such a large amount of information, people often seem to be at a loss, and it is difficult to find out the information needed quickly and accurately [2, 3]. Various educational information management systems have accumulated a large amount of data while giving strong support to universities' educational management planning. Usually, what we can quickly recognize is the information presented on the surface of the data, while some important information hidden behind the data is difficult to obtain directly. Therefore, how to extract useful information for education decision-makers from the massive data generated by the education information management system has become a problem that education administrators must consider [4, 5].

The education management information system is based on the personal information of students and teachers. In the process of establishing the system, it is always emphasized to build a single information card of students and teachers. The main body of a school is students and teachers [6]. Instead, it is necessary to summarize the situation of students and teachers in the school so as to obtain the information of the

school more intuitively and effectively. The study of educational indicators originated in the United States in the mid and late 1920s and was first included in the study of economic indicators and social indicators, among which the social indicators of education can be said to be the embryonic form of educational indicators [7]. With the development of economy and society, many fields have begun to study indicators suitable for independent development, and education is one of the important contents. The evaluation of the function and benefit of the education system has opened a new era of analyzing the education system. At the same time, countries all over the world pay more and more attention to the quality of education. Since then, the research on education indicators has gradually developed. Education indicators provide explicable information for the education system by collecting various education-related information, which can be used for education policy explanation and decision-making.

The United States has issued "Preparing for the Future of Artificial Intelligence" and "National Artificial Intelligence Research and Development Strategic Plan," raising the importance of artificial intelligence to the height of national development strategy. China has also released the "Development Plan for a New Generation of Artificial Intelligence," emphasizing the importance of artificial intelligence, and artificial intelligence is also affecting education to have a profound change. Intelligent education robot uses artificial intelligence technology to interact with students and improve their interest in learning. These forms of intelligent education are mainly customized for students, while there are few intelligent education systems for students [8, 9]. Therefore, based on the above problems and technology, it is urgent to study an intelligent education management system that can combine the advantages of traditional education and artificial intelligence. It helps teachers to assist in the management of students, freeing teachers from the contradiction between students' status and teaching quality, providing transparent teaching quality assistance for parents, providing education assistance management for parents, students, and schools, and making greater contributions to the improvement of students' education quality [10].

1.2. Research Significance. In the actual implementation process, education managers should also learn to collect, analyze, and use data. Through comprehensive and scientific analysis and research of data, it is helpful to put forward valuable suggestions for education management. For different users, the reports provided by the educational information system are different. However, no matter what level of users, they need to understand the content and meaning of educational management indicators in these reports, and what kind of value they have in educational practice [11, 12]. For users at different levels of the system, it is necessary not only to understand the information contained in these educational statistical indicators but also to be able to be applied in the practice of educational management. According to the statistical indicators in these reports, the scientific and rational education management can be enhanced. The data collected in accordance with the educational management indicators are based on the problems that education managers care about, and the results can well reflect the relationship between various educational elements, which is convenient for education decision-makers to comprehensively and intuitively grasp the information hidden behind the educational data [13].

The "Development Plan for a New Generation of Artificial Intelligence" released in July, 2017 emphasized that we should seize the major opportunities of the development of artificial intelligence and build the first-mover advantage in the development of artificial intelligence in China, indicating that China has begun to put artificial intelligence in the core topic of scientific research. Artificial intelligence has also begun to enter various industries and many companies have begun to implement face recognition attendance, which provides a great idea for artificial intelligence-assisted education. Therefore, the combination of artificial intelligence and education, on the one hand, can help teachers to check class attendance and monitor students' status and can assist teachers to monitor students' teaching status [14]. On the other hand, it can also conduct big data analysis based on students' daily fragmented data, so that students can provide personalized learning plans to better improve their teaching quality.

Based on face recognition technology, this study establishes an educational management system. In the system, the real-time attendance and status monitoring of each class can be realized, and the daily class details of students, classes, and teachers can be reported and analyzed. The realization of the system, on the one hand, can help the school to better realize the management of students and teachers and realize the two-way control of education quality. On the other hand, it can help the school to monitor the quality of students' classes and make the quality of classes transparent, so that parents can control students' learning in real time and assist the school and parents to improve the quality of students' learning better.

2. Related Work

2.1. Research Status of Face Recognition Technology. After many years of research and development, face recognition technology has achieved quite good results [15]. In the early stage, relatively backward face recognition technology can only deal with relatively simple images, such as pictures with single background and the face in the image must be in front. The purpose of face detection is to find a high degree of similarity with the face of the region, and the region marked segmentation process. At first, the researchers did not spend a lot of time on face detection, but after the test, they found that the accuracy of each recognition was not satisfactory. Face detection is to extract the salient features of the face image, and face recognition is to extract the features of the face; the existing features are compared to determine which kind of face the feature belongs to, and the two have essential differences. [16, 17].

The geometric feature-based approach is a bottom-up face recognition paradigm. Each person has their own unique features, and each person's face has its own unique features, such as the size of the eyes, the size of the nose, and the

curvature of the eyebrows. The method based on feature recognition aims to find the above invariable features and use these features to locate the face. The recognition method based on algebraic features takes the face image as the model input matrix and performs a series of sentence operations to obtain the face features. The main advantage of this method is that the original gray distribution data of the image can be directly used for training and recognition, and the image can be effectively compressed in the low-dimensional subspace. Compared with other methods, the recognition is simpler and more effective. When deep learning is applied to face recognition, compared with other machine learning algorithms, this algorithm can extract human face features without determining feature rules in advance and finally complete the face recognition process independently. Neural network is a nonlinear modeling method. It collects massive samples for training and learning and automatically extracts useful features for relearning. Finally, the trained network structure parameters are used for face recognition [18]. However, this method also has certain limitations, since it needs a large number of sample data and the longer training time.

The application of face recognition technology in the field of education can provide more powerful solutions to some prominent problems in the current field and play a huge role in various application scenarios, such as face-brushing check-in, student identification, and examination management. The introduction of face recognition for teaching management to bring greater flexibility and reliability can effectively improve the online education environment and students' learning style. The system designed in reference [19] used the facial recognition completed noninductive attendance of students to detect the state of learning of students through facial expression recognition, which provided a new visual angle and way. In order to solve the problem of insufficient supervision of online learning effectiveness, a face perception scheme for online learning was designed [20] and implemented and applied to the effectiveness supervision system of online teaching. Based on face recognition technology, a set of examination monitoring system is designed and developed. The system effectively solves the problems of examinee identity verification, invigilation, and other aspects of the examination room and can effectively prevent the occurrence of cheating phenomenon, such as substitute examination, with strong application value [21]. In view of the existing problems of online learning, such as weak supervision and inability to perceive students' learning behaviors, an online learning behavior perception model based on face recognition technology was constructed to sense and evaluate learners' learning status [22].

2.2. Research Status of University Education Management. The traditional educational management mode adopts manual operation management, which has a large amount of text workload, low efficiency, poor comprehensive utilization of resources, long completion cycle of various statements, and easy to produce operational mistakes, which often makes the management personnel in the complex management of things and cannot achieve a good management effect. The flow of traditional educational administration mode is divided into the following four steps: the first step is to use the computer to carry on the new student registration and establish the management work of the school roll file. The second step is to use the computer to organize classes and arrange courses. The third step is to use the computer to carry on the examination management work. The fourth step is to use the computer to carry on the management work of student achievement and graduation. The traditional educational management is used in the implementation of planned enrollment and planned allocation, and the training mode of corresponding professional talents with a strong position is adopted in teaching, which is suitable for the higher education management under the planned economy system [23]. Its deficiencies become more obvious. First, strict limits on the number of years of study cannot effectively allocate the time for education, reducing the efficiency of education, to the detriment of both individuals and society. Second, the learning content is not selective, and students are not allowed to choose courses and majors that they think are necessary and interesting, which weakens students' learning enthusiasm. Third, the utilization rate of teaching resources is low. Fixed teaching content makes it difficult for emerging subjects and frontier subjects to be transformed into classroom teaching content, and the fixed teaching form is not conducive to the sharing of various teaching resources.

2.2.1. Smart Education. It can get the weak points of students or the defects that teachers fail to take into account, so as to carry out targeted personalized guidance and education management [24]. At present, the application of artificial intelligence is mainly divided into adaptive learning education, virtual assistant, expert system, business intelligence, and other aspects of the wide application. Adaptive learning education is mainly based on the individual student as the unit, according to the progress and content of the student's learning, to specify personalized learning plan and evaluation for students. The intelligent virtual assistant is mainly manifested as virtual teaching assistant and virtual training partner. The expert system mainly aims at providing students with some career planning or intelligent correction services. In the past two years, education management based on artificial intelligence has gradually emerged in various educational institutions and universities, mainly using artificial intelligence technology to improve students' classroom participation and universities' management quality.

Compared with the traditional method of extracting image features by manual design, convolutional neural network (CNN) has a strong learning ability and can learn the characteristics of training samples by itself. Therefore, it also has a strong processing ability for some complex computer vision problems. Reference [25] studied the modeling and processing method of emotional information in network teaching, trained students' emotions with neural network, and built an emotional model of emotional state on this basis. Then, the authors of reference [26] used data mining, emotion analysis, and other technologies, to establish an online learning crisis warning and intervention model to effectively

analyze the learning status and trend of learners and then assist teachers to adjust teaching content and strategies in time.

Reference [27] systematically expounded on the integration of smart education and big data, introduces the practice of smart education in representative regions of China, and shows the planning ideas and framework of big data in education. The architecture of intelligent education system in colleges and universities is studied in reference [28], and a cloud center of intelligent education, a smart campus supporting school education, and a learning-oriented smart city supporting lifelong education are proposed. Through the function of data reporting, education data at all levels can be reported and summarized and stored in a comprehensive database, providing more comprehensive and detailed education data for schools and education departments at all levels. However, on the basis of the data warehouse development decision support environment, sometimes, a data warehouse is required to meet the needs of all end users. But various types of user needs are constantly changing, which requires data stored in the data warehouse have sufficient flexibility and can satisfy all kinds of the user's query and analysis. The study [29] put forward the concept of affective computing and combines it with network teaching to improve learning efficiency. Since then, domestic and foreign researchers have been conducting research and exploration on the combination of affective computing and network learning. By studying the learning behavior, emotion, and state of learners in the network teaching system, the authors of reference [30] established a personalized network learning system. By adding emotional cognition function to the system, the system can perceive and analyze the cognitive situation and emotional state of learners in the process of online learning. Based on the above discussions, the main contributions of this study are shown as follows:

(1) Although the used models are not new, this study is the first time to use the CNN model to realize the monitoring of preclass attendance, in-class state monitoring, and after-class online learning

(2) The whole process management of college education is helpful to improve the management level of modern colleges and universities

3. The Proposed University Education Management Method

3.1. Deep CNN Model. The earliest feedforward neural network is also called multilayer perceptron (MLP), which is the simplest neural network model. Each neuron is arranged in layers. As the simplest neural network at that time, each neuron is connected to the upper layer, the output of the upper layer continues as the input of the lower layer, and there is no feedback between layers. The multilayer perceptron neural network is shown in Figure 1.

In recent years, the CNN model is often used to solve complex image recognition problems. Based on the traditional full-connection layer neural network, CNN adds the convolution layer and pooling layer to form the deep CNN model, which is shown in Figure 2.

The function of the convolution layer lies in the extraction of image features. The essence of the convolution kernel is a filter matrix, which can produce many different effects on the original image. The calculation process of convolution is as follows:

$$\mathrm{CONV}_{(ij)} = \sum_{i}^{m-1}\sum_{j}^{n-1} u_{ij} \times w + b \ (i = 1, 2 \ldots m-1; j = 1, 2 \ldots n-1), \quad (1)$$

where u_{ij} is the input image, m and n are the size of the input image, w is the size of the convolution kernel, and b is the bias constant of the convolution kernel. $\mathrm{CONV}(ij)$ is the characteristic graph output after convolution operation.

CNN adds an activation function layer to the network and analyzes the model better by adopting the feature mapping method of nonlinear function. Then, the mathematical expression of common activation function is introduced one by one. The mathematical expression of sigmoid function is as follows:

$$f(x) = \frac{1}{1 + e^{-x}}. \quad (2)$$

The mathematical expression of tanh function is as follows:

$$f(x) = \frac{e^{x} - e^{-x}}{e^{x} + e^{-x}}. \quad (3)$$

The mathematical expression of ReLu function is as follows:

$$f(x) = \max(0, x). \quad (4)$$

The full name of ReLU function is a rectified linear unit. The function is one of the commonly used activation functions, which is characterized by low computational complexity and no exponential operation. However, it is worth explaining that ReLU function has certain defects in the calculation process. When the data pass through the negative range of ReLU function, the output value is equal to 0. The leaky-ReLu function can solve the above problem as follows:

$$f(x) = \begin{cases} x, & x \geq 0, \\ \alpha x, & x < 0. \end{cases} \quad (5)$$

Therefore, the efficiency of the entire network operation can be improved to a certain extent. The corresponding equations of sig and tanh are as follows:

$$\begin{cases} sig(x) = \dfrac{1}{1 + \exp(-x)}, \\ \tanh(x) = \dfrac{\exp(x) - \exp(-x)}{\exp(x) + \exp(-x)}. \end{cases} \quad (6)$$

The output layer adopts softmax function to normalize, and the probability value in the corresponding category is shown in the following formula:

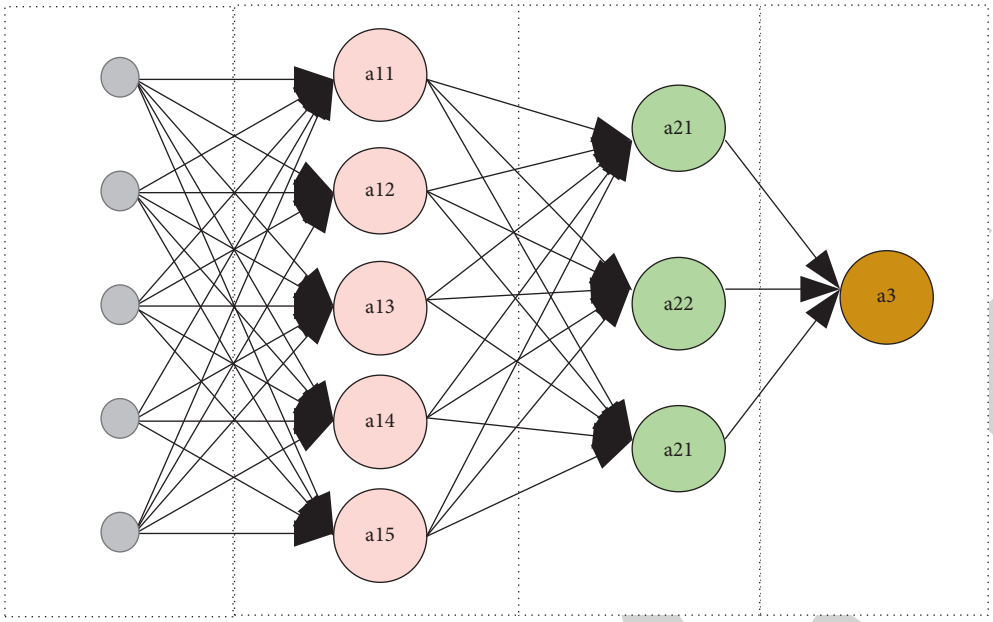

Figure 1: The typical schematic diagram of multilayer perceptron neural network.

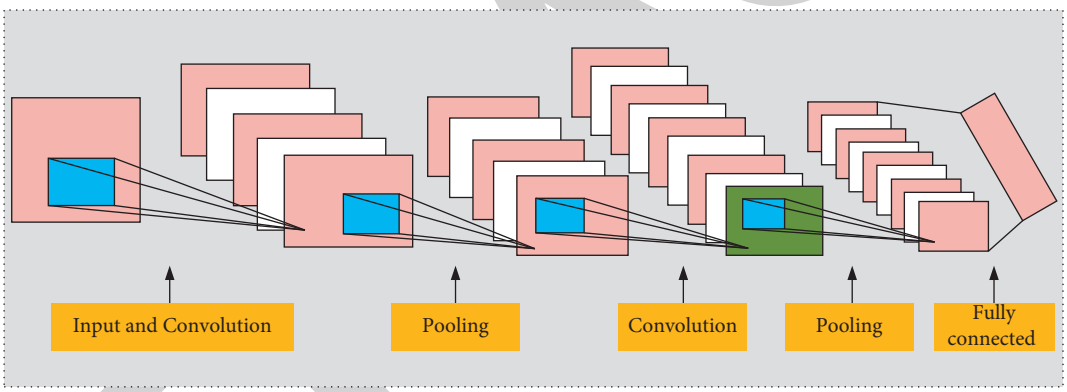

Figure 2: The typical schematic diagram of CNN.

$$h_{w,b}(x_i) = \begin{bmatrix} p(y_i = 1|x_i; w, b) \\ p(y_i = 2|x_i; w, b) \\ p(y_i = 3|x_i; w, b) \\ \cdots \\ p(y_i = n|x_i; w, b) \end{bmatrix} = \frac{1}{\sum_{j=1}^{n} e^{w_j x_i + b_j}} \begin{bmatrix} e^{w_1 x_i + b_1} \\ e^{w_2 x_i + b_2} \\ e^{w_3 x_i + b_3} \\ \cdots \\ e^{w_n x_i + b_n} \end{bmatrix}. \tag{7}$$

In classification tasks, it is a common method to use cross-entropy loss function to evaluate the gap between the predicted value and true value. The cross-entropy (CE) formula is as follows:

$$\text{loss} = -\frac{1}{m} \sum_{j=1}^{m} \sum_{i=1}^{n} y_{ji} \log(\hat{y}_{ji}). \tag{8}$$

The error calculated from the CE function needs to be calculated by back propagation, so as to realize the newer back propagation of model parameters. The original form of the gradient descent method is as follows:

$$\theta := \theta - \alpha \frac{\partial}{\partial \theta} J(\theta). \tag{9}$$

In the experiments in the following sections, this study also verifies that the use of Adam has faster convergence than SGD. The mathematical expression of a common Adam optimizer is as follows:

$$m_t = \beta_1 m_{t-1} + (1-\beta_1) g_t, \quad v_t = \beta_2 v_{t-1} + (1-\beta_2) g_t^2. \tag{10}$$

Therefore, the updating rule of gradient descent is as follows:

$$\theta_{t+1} = \theta_t - \frac{\alpha}{\sqrt{v_t + \epsilon}} m_t. \tag{11}$$

Based on the above discussions, the analysis of university education management based on artificial intelligence proposed in this work is shown in Figure 3. It mainly includes the CNN model-based layer, the student status monitoring layer before class, during class, and after class, and the influencing factor analysis layer of the best educational management.

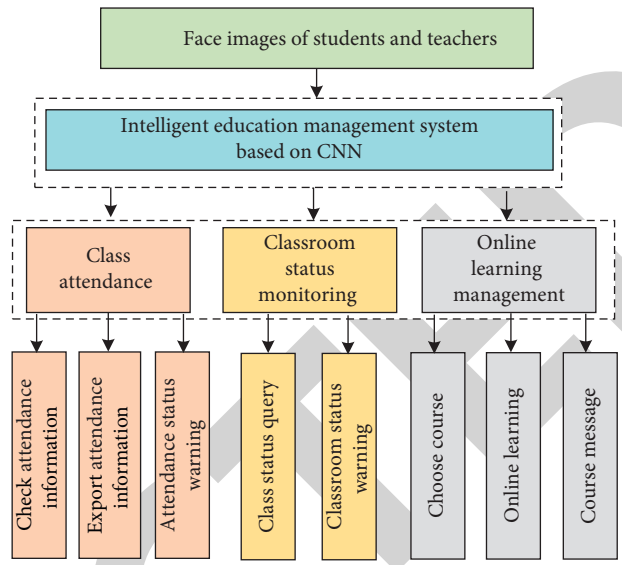

Figure 3: The overall process of the proposed method.

4. Experimental Results and Analysis

4.1. Experimental Data Introduction and Model Setup. The dataset used in the pretraining of algorithm model in the experiment is Fer2013 facial expression dataset, which has a total of 35,886 facial expression pictures, and each picture is $48 * 48$ gray-scale picture, with 7 expressions such as anger, disgust, fear, happy, sad, surprised, and neutral. In the training stage of the algorithm, the model used in the face recognition stage is selected, and the dataset in the training stage is about 54,000 faces detected in the face detection stage, which are cropped and obtained, of which the training set is about 30,000 pictures, and the verification and test set contain 12,000 pictures respectively.

In addition, the specific architecture of CNN model designed in this study is shown in Figure 4. As can be seen from the figure, the designed CNN model includes two convolution layers, two pooling layers and two full connection layers, and the RELU function is selected as the activation function.

4.2. Analysis of University Education Management by CNN. Figure 5 shows the change curves of different activation functions in the CNN model. It can be seen from the figure that under the dataset in this study, different activation functions have different characteristics, but they all have the following characteristics: differentiability: when the optimization method is based on gradient, this property is necessary. Monotone: when the activation function is monotone, the single-layer network is guaranteed to be convex. Range of output values: when the output value of the activation function is finite, the gradient-based optimization method is more stable, because the representation of features is more significantly affected by finite weights. Model training is more efficient when the output of the activation function is infinite, but in this case, a smaller learning rate is generally required.

Face detection also includes skin color detection, skin color region segmentation, and CNN algorithm feature extraction. The program flowchart of student attendance system designed in this study is shown in Figure 6. Among them, the user registration module and personnel information management module mainly collect the basic information of attendance personnel, such as names and other basic information. After collecting the face pictures of the attendance personnel, the system will push and segment the faces into the system for training and extract the face images into 128-dimensional feature vectors through the convolutional network. Then, the face picture is submitted together with the user's name and other basic information, in which the first part is submitted as a user face registration module, and the second part is submitted as a personnel information management module.

The class status monitoring module is used to monitor the class status of students during class and give timely warnings. The specific flowchart is shown in Figure 7. After the user logs in to the system, the class status monitoring button is clicked, and the system determines whether the user is the super administrator. If you are a super administrator, the class status information of all classes is displayed. If you are a common user, only the class status information is displayed. Before class, users click the class status monitoring button, and the system starts to monitor the class status. When the system determines that students' concentration is 0 or their facial expressions remain motionless for a long time in class, a status warning will be issued to the system.

The class status sequence diagram is shown in Figure 8. After the user enters the correct user name and password and successfully logs in to the system, different information will be displayed according to the permission. The user clicks to start the class. The front end sends a post request to the status monitor, and the status monitor controller receives

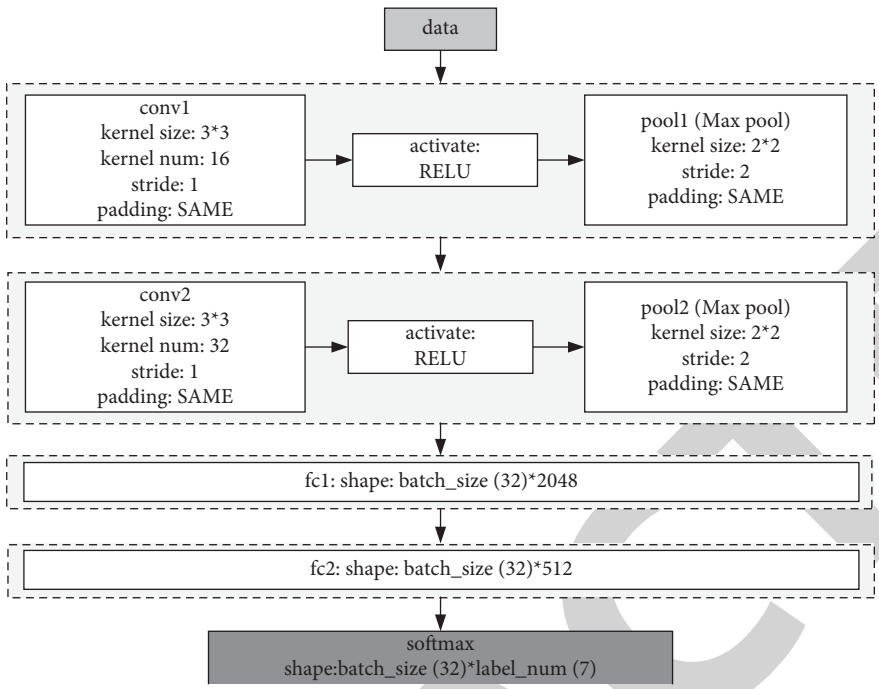

Figure 4: The settings of the CNN in this study.

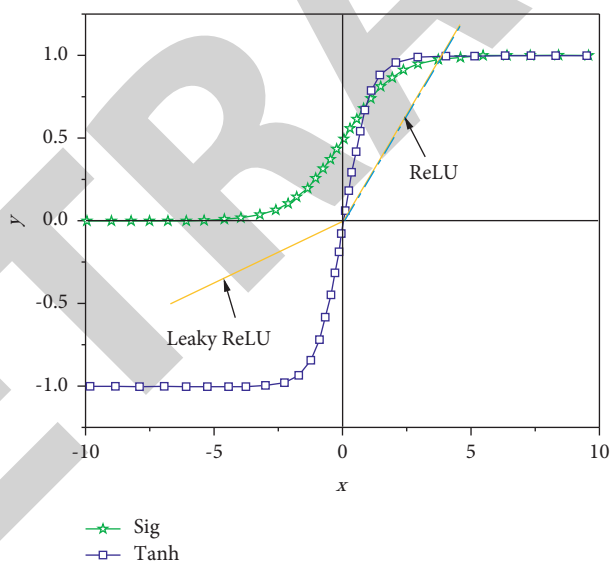

Figure 5: The curves of different activation functions of CNN.

the classic message and calls the start status monitor method to start a new thread for each class through the thread pool. The video to be checked is taken out from the address of the server where the data reside. The video here uses the written interface to transmit data from the camera to the destination address using RSTP protocol and store it in the specified format. The returned identification information is then fed into the database for updating and displaying on the interface.

In order to obtain the user's real learning state of face data, this study designed a traditional online learning module. After logging in to the system, students can select corresponding courses according to their interests and learning needs from the curriculum list on the home page. After entering the course, students can view the details of the course, select the corresponding chapter, and then study online. After learning a chapter, students can comment on the course information or leave a message, so that teachers can check students' feedback on the course in time. The flowchart of students' online learning is shown in Figure 9. In the design process of online learning module, the following classes are mainly involved: Course Detail View, Course Info View Add Comments View, Video Play View, and Study Info View, corresponding to course details, course

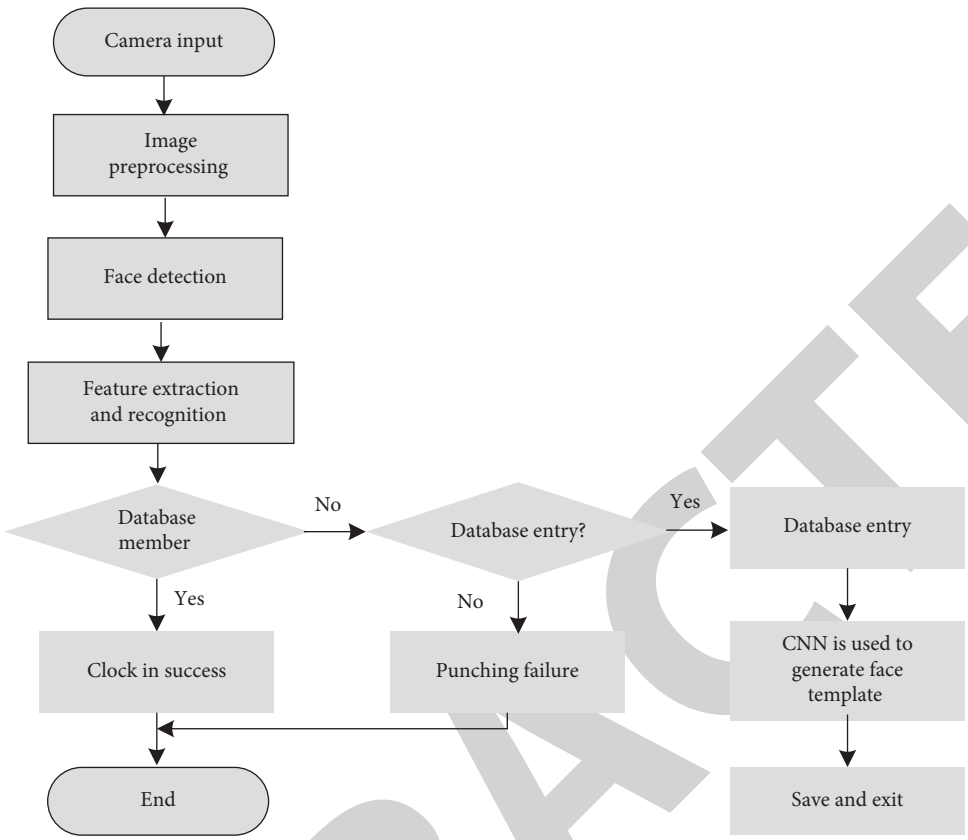

Figure 6: The flowchart of face recognition attendance system.

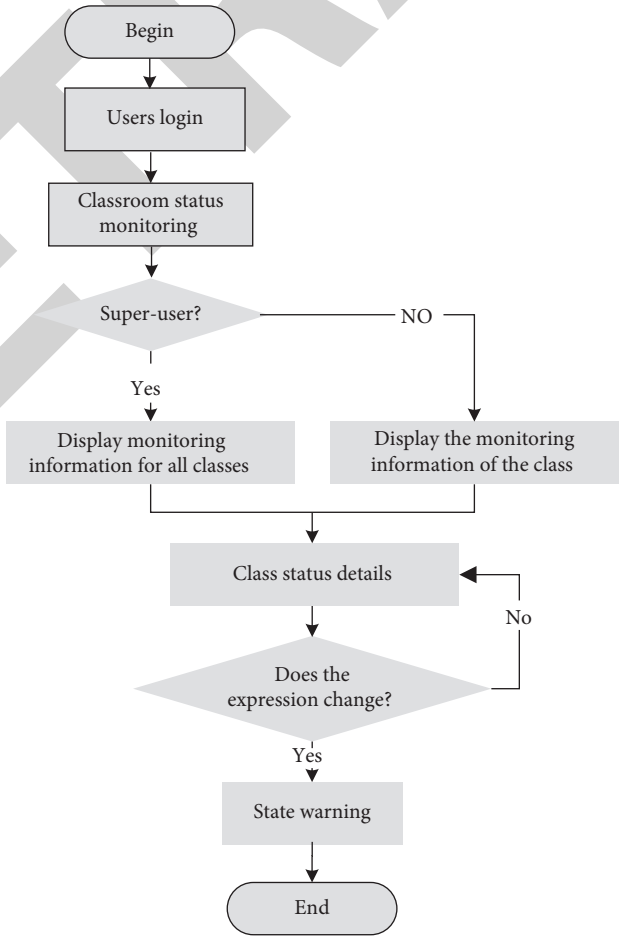

Figure 7: Flowchart of class status monitoring.

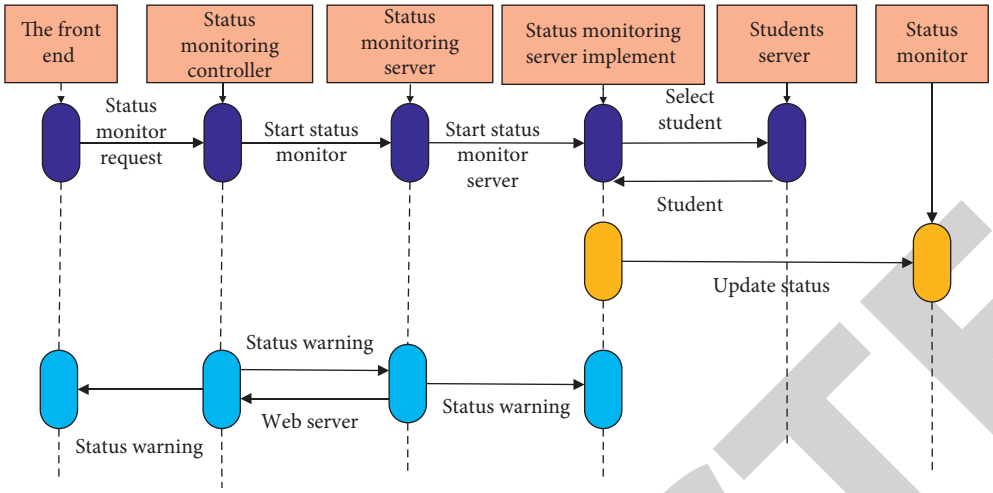

Figure 8: Class status sequence diagram.

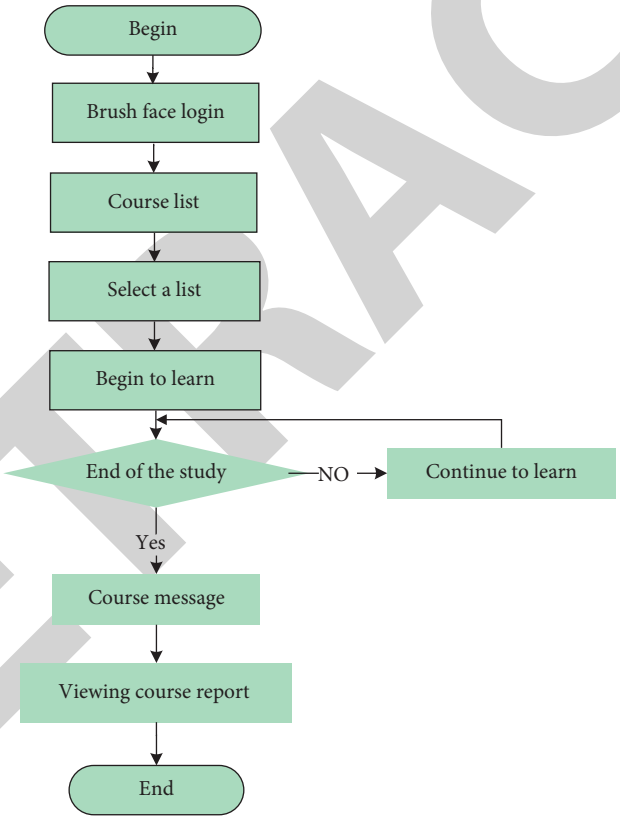

Figure 9: Flowchart of online learning.

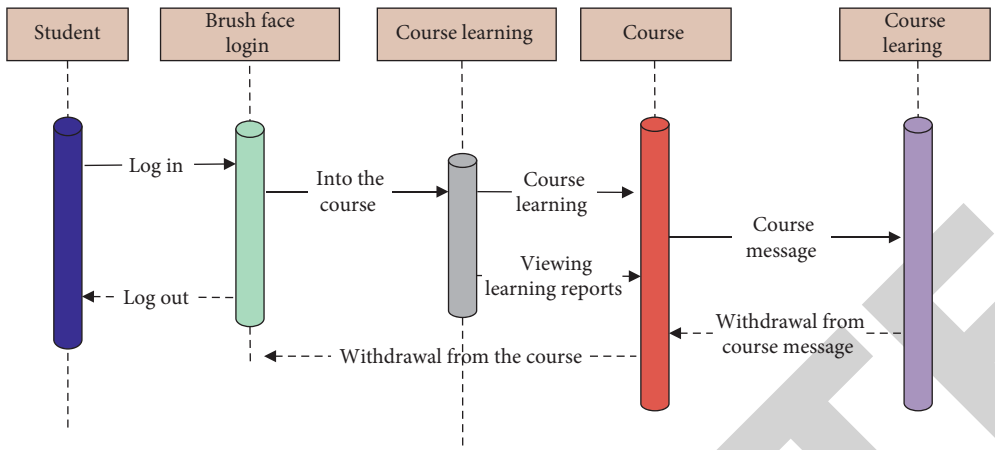

Figure 10: Online learning sequence diagrams.

information, adding comments, video playback, learning information statistics, etc. The sequence diagram of online learning is shown in Figure 10.

5. Conclusions

The system in this study uses face recognition and expression recognition to auxiliary management students; on the one hand, it can assist teachers in real-time monitoring of the state of students and give warnings, and on the other hand, it can also be targeted to improve the way of teaching for teachers reference scheme is put forward.

The system uses face recognition in the class attendance module to realize students' insensitive check-in. The CNN model built has achieved 95% accuracy in face recognition and can check in students entering the classroom within 2 s. In the class status monitoring module, face recognition is used to recognize faces and judge students' concentration. Expression recognition was used to judge the state of students' teaching to monitor the quality of teachers' teaching. Although the method in this study has achieved good results, it is still purely data driven and lacks interpretability. The focus of future research may be to integrate the characteristics of more human students into the model.

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 author declares that there are no conflicts of interest.

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Retraction

Retracted: Analysis of Painting Elements of Tea Culture and Art Works Based on Image Perception

Security and Communication Networks

Received 8 January 2024; Accepted 8 January 2024; Published 9 January 2024

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

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[1] H. Zhao, "Analysis of Painting Elements of Tea Culture and Art Works Based on Image Perception," *Security and Communication Networks*, vol. 2022, Article ID 2439464, 9 pages, 2022.

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Research Article

Analysis of Painting Elements of Tea Culture and Art Works Based on Image Perception

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The art works take tea as the theme of painting elements, and depict the content of Chinese traditional culture by showing the connotation of tea culture painting elements. For example, Wen Zhiming, a painter and calligrapher in Ming Dynasty, is best at painting landscape figures. He often uses tea as the theme in his art works, adding the elegant, natural, and simple painting elements of tea into his works, and has created many famous art works that are spread around the world. In recent years, with the deepening of the research on image processing technology, image perception technology has attracted more and more researchers' attention, which has made great achievements and progress in image perception algorithms. This paper studies the tea culture elements of art works based on image perception algorithm. The accuracy of similar image pairs is the ratio that similar image pairs are correctly recognized. When the number of experiments reaches 25, the image sensing algorithm in this paper has the highest accuracy rate, with the accuracy rate of 99.8%, when the number of experiments reaches 20, the ant colony algorithm with the accuracy rate of 96.5%, when the number of experiments reaches 20, and finally the artificial intelligence algorithm with the accuracy rate of 96.0%. The correct rate of similar image pairs is the correct recognition rate of tampered image pairs. When the number of experiments reaches 10 times, the correct rate of image perception algorithm in this paper still ranks first, with the correct rate of 99.8%, when the number of experiments reaches 25 times, the artificial intelligence algorithm with the correct rate of 98.2%, and finally when the number of experiments reaches 10 times, the ant colony algorithm with the correct rate of 96.2%. It can be seen that the numerical values in this column show the robustness of this algorithm. Through the cultivation of students' image perception ability, it can promote students' appreciation ability of tea culture painting elements, learn the knowledge of tea culture painting elements beauty in a deeper level, master the skills of beauty, and improve their artistic temperament and artistic accomplishment.

1. Introduction

There are many famous art works in Chinese history. Among them, many art works take tea as the theme of painting elements. They depict the content of Chinese traditional culture by displaying the connotation of painting elements of tea culture. For example, Wen Zhengming, calligraphers, and painters in the Ming Dynasty, who are best at painting landscape figures, often use tea as the theme in art works and add the elegant, natural, and simple painting elements of tea to their works, He created many famous art works and spread them all over the world [1, 2]. No matter what techniques or methods are adopted in painting, the final expression is the painter's personal thoughts and feelings and his cognition of society. The subjective consciousness has not changed due to the reference to the traditional art of tea culture, but only uses some excellent painting methods to more appropriately express personal subjective emotions, and well integrates Chinese painting skills and even Chinese traditional culture [3]. Because tea culture began to integrate into book art works, the rise of tea culture was perfectly displayed by art works, diversified the forms of art works, and provided inspiration for those writers who like tea. Chinese paintings generally use less than more in the performance of characters. The background is often left blank and mainly outlined by lines. The brush is becoming more and more freehand, advocating simplicity, and then talking about the interests of survival, clumsiness, and plain,

focusing on the expression of the air and charm of the characters in the painting. Westerners often think that Chinese painters do not understand perspective. In fact, Chinese painters pursue the essence of things, which is the reverse perspective that appeared as early as the Song Dynasty [4, 5]. Moreover, the increase of art works, especially those based on tea elements, can better help people understand the elementalization of tea painting, improve people's appreciation of art works, and make their aesthetics develop in a diversified direction [6].

In recent years, with the deepening of the research on image processing technology, image perception technology has attracted more and more researchers' attention, which has made great achievements and progress in image perception algorithms. Image perception algorithm maps the characteristic data of an image to a short string code, which is a compact representation based on the image content [7, 8]. It makes the visually identical image map to the same or similar image, and different images map to different degrees [9]. The technology of expressing image perception information as a brief summary is an efficient and safe solution, which has been applied in the fields of image authentication, tampering detection, image duplication detection, image indexing, image retrieval, digital forensics, and image quality evaluation [10].

Because the digital image of art works has a large amount of data, it is not easy to manage and maintain the digital image, so how to reduce the data representation of digital image has become an important problem [11, 12]. Image perception algorithm can convert image data in art works into binary sequences of hundreds or thousands of bits, which greatly reduces the storage of digital images and brings great convenience to image management and maintenance. Cultivating students' image perception ability of art works in art teaching can improve students' appreciation ability to a certain extent and experience the emotion that the author wants to convey in the works [13]. In the art teaching based on image perception algorithm, cultivating students' image perception ability of tea culture painting elements of art works can improve students' understanding of beauty to a certain extent [14]. Therefore, finding and feeling the beauty of tea culture painting elements based on image perception algorithm is the premise of creating beauty. Through the cultivation of students' image perception ability, students can promote their appreciation of tea culture painting elements, learn the knowledge of tea culture painting elements at a deeper level, master beauty skills, and improve their artistic temperament and artistic accomplishment.

I put forward the following innovations in this paper. The specific contents are as follows.

(1) In this paper, the features of perceptual images are extracted. Perceptual feature extraction is the focus and key of current research. The effectiveness and reliability of perceptual feature extraction will directly affect the robustness and uniqueness of image perceptual hash sequences. In the aspect of image perceptual feature extraction methods, how to extract the feature points that best represent the image features is the focus and key of people's research.

(2) The embodiment of tea element in art works is explored. Many Chinese painters are influenced by Confucianism in tea culture. Many of them are ambitious, but they have no choice but to have a bad career. Their patriotism and passion have nowhere to be released. Finally, they choose to "be independent" in tea products.

The overall structure of this paper consists of five parts.

The first chapter introduces the background and significance of tea culture elements in art works. The second chapter mainly describes the research status of painting elements in art works at home and abroad and the research work of this paper. The third chapter discusses the realization of painting elements of art works with lost image perception. The fourth chapter carries out the experiment and analyzes the results. The fifth chapter is a summary of the full text.

2. Related Work

The main reason why the tea culture painting elements of Kuhn's art works are deeply loved by artists is that in the eyes of artists, tea culture can place its noble character and lofty meaning, which can bring different tastes to people [15]. Scott put forward that tea culture has formed a unique cultural system, is the product of the development of human civilization, and plays an important role in the improvement of human civilization. This also shows that tea culture needs people to inherit, and constantly innovate while not studying in Dunant, so that tea culture can complement and develop together with other cultures [16]. Von and Bonnie put forward that because of the different kinds of tea culture painting elements in art works, the spatial properties are different. Art is an art in which space is the way of existence. There are mainly calligraphy, sculpture, painting, architectural art, etc. Art can only be expressed through modeling, while plastic arts must depend on space [17]. Dubus put forward that Chinese tea culture has long been rooted in people's hearts, and it plays a complementary role in the development of Chinese history and culture, and is inherited together with the moral tradition [18]. Clay proposed that there are many representative Chinese artists in all fields of painting, and at the same time, a large number of abstract works of art with artists' subjective ideas are springing up, among which tea culture painting elements occupy a place in China [19]. Melissa put forward that different art works have different painting elements and different material materials. Only by relying on material materials can art works exist. Different material choices affect the artistic image created by art works. The characteristics of materials are more important in oil painting, Chinese painting, printmaking, and other works [20]. Caldarola proposed that tea culture can not only express various thoughts, but also abstract the combination of its own tea ceremony, thus producing countless profound meanings, making it reach the realm of

"I have things in me, and I have things in me." Moreover, during the historical development, tea culture has not lost its unique light because of the baptism of history, and the characters contained in tea culture have unique and unified meanings in different dynasties and works [21]. Mabrouk pointed out that artists' expressions of tea culture painting elements in art works are increasingly rich and diverse, not only through naturalistic abstraction of picture expression through natural landscapes or natural traces of all things in the universe, but also by adding a series of nontraditional painting materials such as paper, cloth, rope, and other comprehensive materials of painting tools into the artistic concept of creation [22]. Nanay put forward that the main painting element of art works is the presentation of theme, which is the most important part of art works, and the creation of painting element theme is also one of the favorite expressions of art works, including tea culture theme [23]. Kim proposed to improve our understanding of tea culture painting elements in art works, and better explained the relationship between reference and innovation in tea culture painting elements in art works. In addition, this is obviously also conducive to the inheritance and development of tea culture painting elements in art works [24].

Based on image perception, this paper analyzes the painting elements of tea culture in art works, and describes the content of tea culture in detail through art works. Readers are interested in tea culture by watching art works and feeling the meaning of tea culture, so that tea culture aesthetic works can play a role of teaching in fun, which is also the wish of all people who want to understand tea culture. Under the image perception algorithm, materials have different material and texture characteristics, which can produce different artistic effects of tea culture in art works. Therefore, in art creation, paying attention to the performance of tea culture painting elements and materials has a great impact on the style of works. The texture of materials, that is, the surface texture of materials, depends on touch and vision, and people can feel the degree of smoothness, roughness, and fineness. The texture in painting is generally called the texture element in painting. The cognitive process of image includes two stages. The first is the response process of human visual system to optical signal input, and then the process of brain recognition, judgment, association, and memory of the received signal. The research results of human visual system have been mainly used in image quality evaluation.

3. Realization of Painting Elements of Art Works Based on Image Perception

3.1. Image Perception Algorithm. Image perception algorithm extracts and compresses the media perceived content and information to form a brief summary, which is used to record or identify the media content, or further used to find the tampered or tampered location of the media content. Because of its wide application prospect, image perception algorithm is attracting more and more researchers. The perceived value of the image is calculated by using the information such as the gray difference of adjacent pixels [25]. The widely used average image sensing algorithm mainly uses the low-frequency component of the image, which is the area with small brightness change, to describe the information contained in the whole image. The computational complexity is low, but the accuracy of image similarity detection is low. The image sensing algorithm proposed in this chapter is divided into the following steps. The first step is to transform the input image into a normalized image through preprocessing. The second step is to extract the features of the image [26]. Then image perception is generated by semisupervised training. Next, the threshold of a single image is determined by adaptive threshold decision. Finally, the threshold and image perception algorithm are combined to generate the final image. The flowchart of image perception algorithm is shown in Figure 1.

For reference images and received images, we use semisupervised learning algorithm for generation and image authentication. Generally speaking, Gaussian low-pass filtering can be realized through convolution mask. Let $G(i, j)$ be the element in row i and column j of the convolution mask. It can be calculated by the formula

$$G(i, j) = \frac{G(i, j)}{\sum_i \sum_j G(i, j)}, \tag{1}$$

$G(i, j)$ is defined by the formula

$$G(i, j) = e^{-\left(i^2+j^2\right)/2\sigma^2}, \tag{2}$$

σ in the above formula is the standard deviation of all elements in the convolution mask.

Suppose there are N images in the training set, and L images are selected as the marker image, then $L \leq N$. We represent the features of a single image as $X \in R^M$, where M is the extracted feature length. Then the characteristic expression of all images

$$X = \{X_1, X_2, ..., X_N\}. \tag{3}$$

Including $X \in R^{M\times N}$. The feature of the marked image is represented as $X \in R^{M\times L}$. Note that these characteristic matrices are normalized to zero centered.

This function can be defined as a formula

$$H = W^T X. \tag{4}$$

Therefore, the function of a single image is defined as a formula

$$h_i = W^T X_i. \tag{5}$$

In order to learn a W that maximizes both the empirical accuracy of the marked image and the hashbit variance of all images, the empirical accuracy of the marked image is defined as a formula

$$P_1(W) = \sum_{\left(X_i, X_j\right)} E_{ij} h_i h_j. \tag{6}$$

It can be seen from the above properties that traditional image perception is very sensitive to the change of multimedia information. In multimedia information processing,

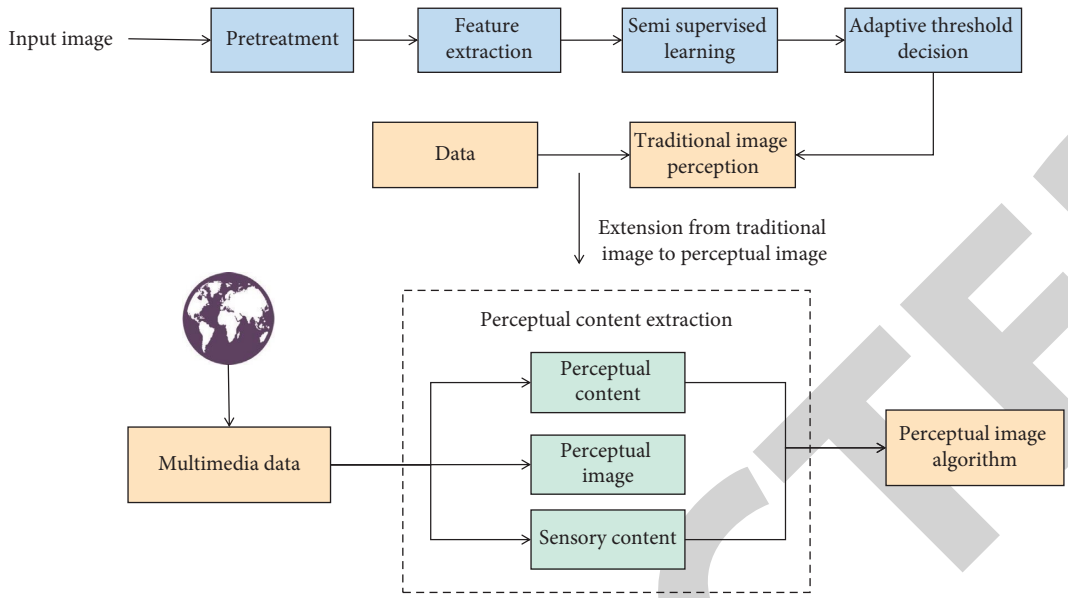

Figure 1: Flowchart of image perception algorithm.

we often use some information processing means, such as compression. These operations will undoubtedly change the bit representation of information, but they have not changed the authenticity and integrity of information, so the traditional hash function obviously cannot meet the requirements. Different from traditional image perception, the image perception algorithm in this paper is closely related to people's subjective perception. This is because the characteristics of multimedia information are determined by people's cognitive psychological process of multimedia, which means that for the same multimedia data, because people's cognitive psychological process is different, the processing process of multimedia data will be different. Image perception algorithm is a big branch, and its feature extraction and coding stage need to contain more visual perception information to meet its robustness requirements. However, the current research on image perception algorithm lacks the consideration of human visual characteristics, and the features concerned are still on the general image features such as image grayscale and feature points. Classical human visual system reflects the visual features of images from multiple angles by multichannel decomposition, and integrates the evaluation results of each channel by error merging. However, the current image perception algorithms are often based on the extraction of a certain image feature, and because of the limitations of the selected features, the algorithms often show performance deviations for different attacks. The purpose of image preprocessing is to eliminate some useless or irrelevant information, such as noise, which affects the original image, preserve the real information of the image to the maximum extent and reduce the amount of data to the maximum extent, thus improving the reliability and effectiveness of feature extraction. There are many methods of image preprocessing, such as geometric transformation, image normalization, smoothing, and image enhancement. In this paper, discrete cosine transform (DCT) is used to extract perceptual features. In this process, the data representation of images is mapped from 2D to 1D feature vectors, and the 1D feature vectors have the following features: if the 1D feature vectors of images with the same or similar content are the same or similar, on the contrary, the 1D feature vectors of images with different content are different, that is, their perceptual distance is larger than the threshold value. The experimental results are shown in Figure 2.

Perceptual feature extraction is the focus and key of current research. The effectiveness and reliability of perceptual feature extraction will directly affect the robustness and uniqueness of image perceptual hash sequence. In terms of image perceptual feature extraction methods, how to extract the feature points that can best represent the image features is the focus and key of people's research.

The matching standard of image sensing algorithm is calculated according to the sensing distance between two hashes. Then, for image perceptual hash sequences in binary vector form, their perceptual distance is the normalized Hamming distance, which can also be called bit error rate, which can be defined as follows:

$$\begin{aligned} BER &= d_{ij} \\ &= \frac{1}{N}\sum n = 1N\left|\left(h_i\right) - \left(h_j\right)\right|, \end{aligned} \tag{7}$$

N represents the length of image perception hash, h_i and h_j. Theoretically, when comparing two images with similar perception content, $BER \approx 0$. If the image perception content is different, the smaller the degree of similarity, the larger the BER should be.

Γ is used to represent the whole probability density space of d_{ij}, which is divided into Γ_{H_0} and Γ_{H_1} by the threshold T. Their relationship can be explained by the following expression:

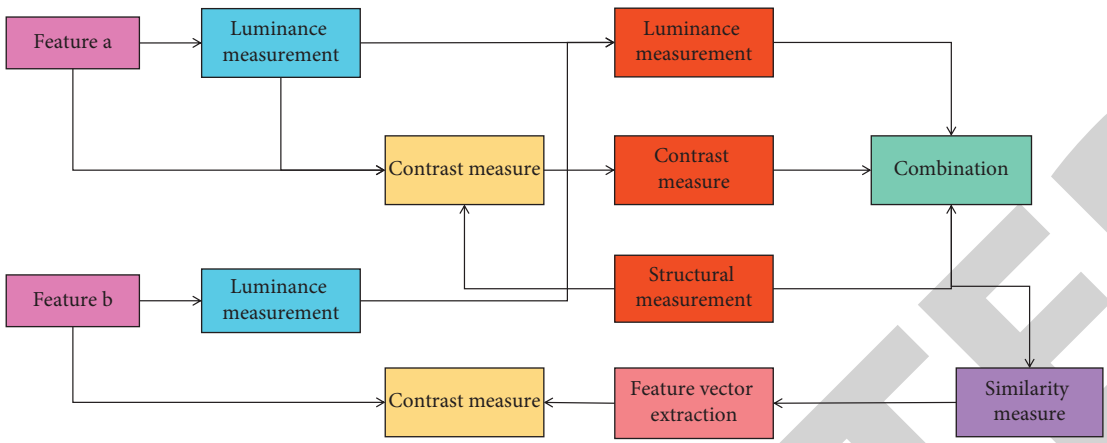

Figure 2: Perceptual image feature extraction.

$$\Gamma_{H_0} \cap \Gamma_{H_1} = 0,$$
$$\Gamma_{H_0} \cup \Gamma_{H_1} = \Gamma. \tag{8}$$

Further, we can get the false connection rate in FAR certification and the false recognition rate in FRR certification, which are defined as follows:

$$FAR = D\left(d_{ij} \in \Gamma_{H_0} | H_1\right),$$
$$FRR = D\left(d_{ij} \in \Gamma_{H_1} | H_0\right), \tag{9}$$

FAR represents the uniqueness of image perception sequence, while FRR represents the robustness of image perception sequence.

The low-frequency components of the image are obtained by orthogonal transformation. As long as the mutual spatial relationship between the images remains unchanged, it can provide a good effect of similar image recognition. However, most of the image perception values of these algorithms can only represent an estimated value compared with the average frequency of the image, and cannot provide the real low-frequency properties of the image. On the one hand, these feature information reflect the perceptual features of the image; on the other hand, they also make the algorithms based on them robust to various content maintenance operations and transformations to varying degrees. However, these image perception algorithms do not do special research on the process of human perception of images and the perception characteristics of human vision.

3.2. Analysis of the Development Process of Painting Creation. For the creation of art works, artists will collect all kinds of materials, so that inspiration can be inspired from them. In the long history of China, many artists' inspiration comes from their own lives. Artists generally prefer to combine their works with nature, which makes their works more intimate and acceptable to viewers. From the analysis of the development process of tea culture, painters have the habit of drinking tea since ancient times. They believe that in the process of drinking tea, the integration of man and nature can be achieved. In the mountains and rivers, enjoying a cup of green tea quietly will relax both body and mind. Many of them are ambitious, but they have no choice but to have a bad career. Their patriotism and passion have nowhere to be released. Finally, they choose to "be independent" in tea products. At the same time, painters will also feel Taoist thoughts from the tea culture, and some of them are far away from the noise of the world, living in the mountains like a paradise. This attitude towards life, which is free from the world, liberates their mind and body and calms their hearts. When painting, they have a deeper understanding of nature and life, and the connotation of their works is rich in tea culture. Among Chinese art works, the artistic conception of art works is not expressed through the inherent form, but the integration of white real life and painting art, and the use of color to express its cultural connotation, so as to blend tea elements with painting elements, thus showing aesthetic thoughts and making works contain classical essence, thus highlighting the progress of the times. Art works need a lot of materials and inspiration. Throughout the 5000-year history of Chinese civilization, the paintings of ancient Chinese painters are closely related to life. By seeking inspiration and feeling emotions in their own lives, they yearn for a peaceful and simple artistic conception, like to be close to nature, and express their emotions in it, so that their paintings are more full of vitality and rich in forms.

The habit of drinking tea has been popularized. Generally, tea is used to entertain guests, which also provides a background for ancient artists to create many works about tea production and picking, which can not only clearly understand the artistic conception of the author, but also touch the feelings of the viewer. Through the application of water elements and painting elements, the spiritual metaphor is added to the painting. Artists can also transform the way of life into the way of creation through the integration of elements, so that the artistic conception of painting can become the aesthetic pursuit of spirit. It can also be said that if painters apply the tea element well, they can combine real life and build the cultural value behind tea. In the process of painting, painters pursue the perfect combination of nature and painting. From painting, people can experience their

Table 1: Content retention operation parameters of training set.

Content retention operation	Parameter value	Parameter value	Quantity
Average filtering	Window size	1, 2, 3, . . ., 10	10
Gaussian blur	Window size	1, 2, 3, . . ., 10	10
Motion blur	Window size	1, 2, 3, . . ., 10	10
Image sharpening	Parameter alpha	0.05, 0.14, . . ., 0.93	10
Total			40

Table 2: Content retention operation parameters of test set (I).

Content retention operation	Parameter value	Parameter value	Quantity
Average filtering	Window size	3	1
Gaussian blur	Window size	2	1
Motion blur	Window size	2	1
Image sharpening	Parameter alpha	0.48	1
Total			4

understanding of freedom and their desire for inner freedom. Tea culture flourished in the Tang Dynasty. Before the Tang Dynasty, there was very little combination of Chinese paintings and tea. One of the earliest paintings recorded in history, mainly in the teahouse, is the painting of tuning the piano and sipping tea in the Tang Dynasty. This is a hand-painted traditional Chinese painting, which depicts the leisurely life of palace women while listening to the piano and drinking tea. In order to achieve the best effect of tea culture, we need to analyze the basis of tea culture, observe the relevant concepts of tea culture, and let the creators have a certain understanding of the knowledge system of art works, so as to effectively integrate the two and achieve the best effect. The integration of painting and Chinese tea culture can be traced back to the prosperous Tang Dynasty. Since the prosperous Tang Dynasty, a very close relationship has been established between Chinese art works and tea culture. Under this cultural background, tea culture has a more profound impact on painters' painting thinking, and more and more excellent art works have emerged, which not only promoted the inheritance and development of tea culture, but also promoted the innovation and reform of Chinese art works.

4. Experimental Results and Analysis

4.1. Training and Testing Process. In order to ensure that the images in the training set are different from those in the test set, we selected 311 nonrepetitive original images and corresponding tampered images, totaling 622 images. Four types of content retention operations are tested, and each content retention operation has 10 parameters. The specific parameters are shown in Table 1.

After adding the content retention operation, 66,130 images are generated as our training data. We randomly selected 10,000 images from 66,310 images as a subset of markers. Semisupervised training method is used for each content retention operation.

In the test, we selected 225 duplicate original images and their corresponding set of tampered images to determine the threshold of each image. We named it the first test set, and then used 225 duplicate original images and their other set of tampered images to test the performance of adaptive threshold. We named it the second test set. Some images of the test set are shown in Table 2.

In order to effectively verify our method, we use the second set of test sets to verify the effectiveness of the algorithm. The retention operation is added to the second set of tests, and then the features are extracted and combined with the trained w calculation to generate an image, as shown in Table 3.

In terms of performance analysis, the method proposed in this chapter is compared with ant colony algorithm and artificial intelligence algorithm to test the accuracy of similar images in art painting elements, and gradually improve the performance of the algorithm. The experimental results are shown in Figure 3.

It can be seen from Figure 3 that the accuracy rate of similar image pairs is the ratio that similar image pairs are correctly recognized. When the number of experiments reaches 25, the image sensing algorithm in this paper has the highest accuracy rate, with the accuracy rate of 99.8%, when the number of experiments reaches 20, the ant colony algorithm with the accuracy rate of 96.5%, when the number of experiments reaches 20, and finally the artificial intelligence algorithm with the accuracy rate of 96.0%. It can be seen that the image sensing algorithm in this paper is the value in this column, which shows the robustness of the algorithm.

The method proposed in this chapter is compared with ant colony algorithm and artificial intelligence algorithm to test the accuracy of tampered image pairs in tea culture elements of art works. The experimental results are shown in Figure 4.

As can be seen from Figure 4, the correct rate of similar image pairs is the correct recognition rate of tampered image

Table 3: Content retention operation parameters of test set (II).

Content retention operation	Parameter value	Parameter value	Quantity
Average filtering	Window size	1, 2, 3, 4, 5, 6	5
Gaussian blur	Window size	1, 2, 3, 4, 5, 6	5
Motion blur	Window size	1, 2, 3, 4, 5, 6	5
Image sharpening	Parameter alpha	0.1, 0.2, . . ., 0.4	5
Total			20

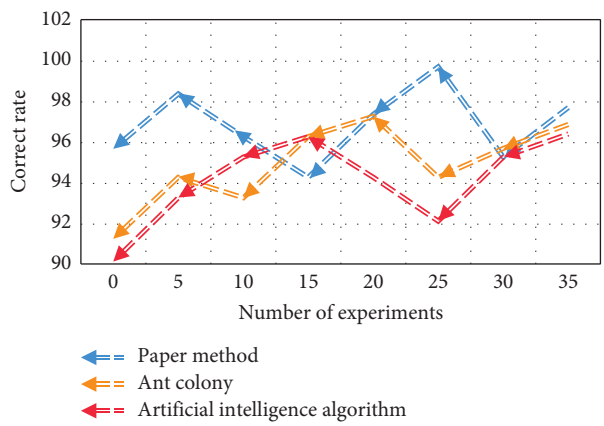

Figure 3: Accuracy of similar images in tea culture elements under different algorithms.

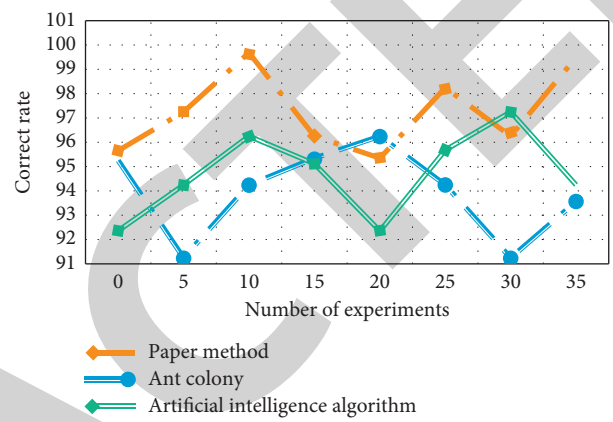

Figure 4: Correct rate of tampering images in tea culture elements under different algorithms.

pairs. When the number of experiments reaches 10 times, the correct rate of image perception algorithm in this paper still ranks first, with the correct rate of 99.8%, when the number of experiments reaches 25 times, the artificial intelligence algorithm with the correct rate of 98.2%, and finally when the number of experiments reaches 10 times, the ant colony algorithm with the correct rate of 96.2%. Therefore, it can be concluded that the correct rate of tampered image algorithm in this paper is the highest among the tea culture elements, which shows the advantages of this algorithm.

4.2. Distinguishing Performance Experimental Analysis. In this experiment, the robustness of tea culture elements in art works under different content retention operations was tested, and the average filtering and Gaussian blur were compared. The experimental results are shown in Figure 5.

It can be seen from Figure 5 that the average Hamming distance under different content saving operations of painting elements of art works is shown. The x-axis under average filtering and Gaussian blur preserving operation is the 10 parameter values of each content preserving operation. The y-axis is the average distance for each parameter. It can be seen that the average distance is no more than 5. On the whole, the average Hamming distance under the preservation operation of tea culture elements in all art works is no more than 15.

Then, the experiment tested the robustness under the retention of tea culture elements in different content art works, and compared the experimental results for motion blur and image sharpening, respectively. The experimental results are shown in Figure 6.

It can be seen from Figure 6 that the average Hamming distance under different content preservation operations of tea culture elements in art works is also shown. The x-axis under motion blur and image sharpening retention operation is the 10 parameter values of each content retention operation. The y-axis is the average distance for each parameter. It can be seen that the average distance is no more than 5. Overall, the average Hamming distance under all content saving operations is still no more than 15.

In fact, the embodiment of robustness and discrimination is closely related to the threshold we choose. In this experiment, the change of different image loss accuracy rate is tested according to the detection performance of tea culture elements under different thresholds. The robust discrimination results under different thresholds are shown in Figure 7.

As can be seen from Figure 7, robustness is expressed by the percentage of correct recognition of similar image pairs of tea culture elements in art works, and distinctiveness is expressed by the percentage of correct recognition of different image pairs. It can be seen that the smaller threshold of painting elements in art works can improve the recognition ability of the algorithm, but it will reduce the robustness. Similarly, a larger threshold can improve the robustness of hashing, but weaken the distinguishing ability. In practical application, the appropriate threshold can be selected according to different requirements.

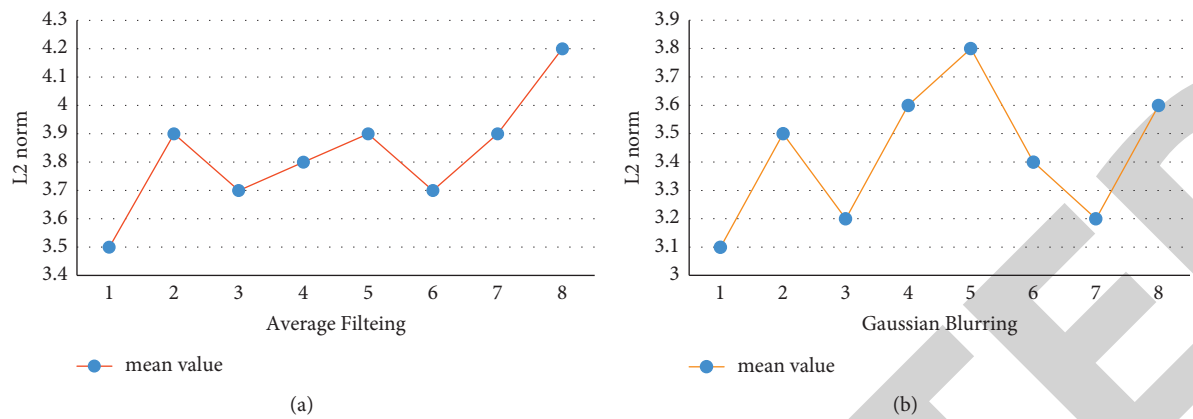

Figure 5: Robust performance of tea culture elements under average filtering and Gaussian fuzzy retention. (a) Average filtering. (b) Gaussian blur.

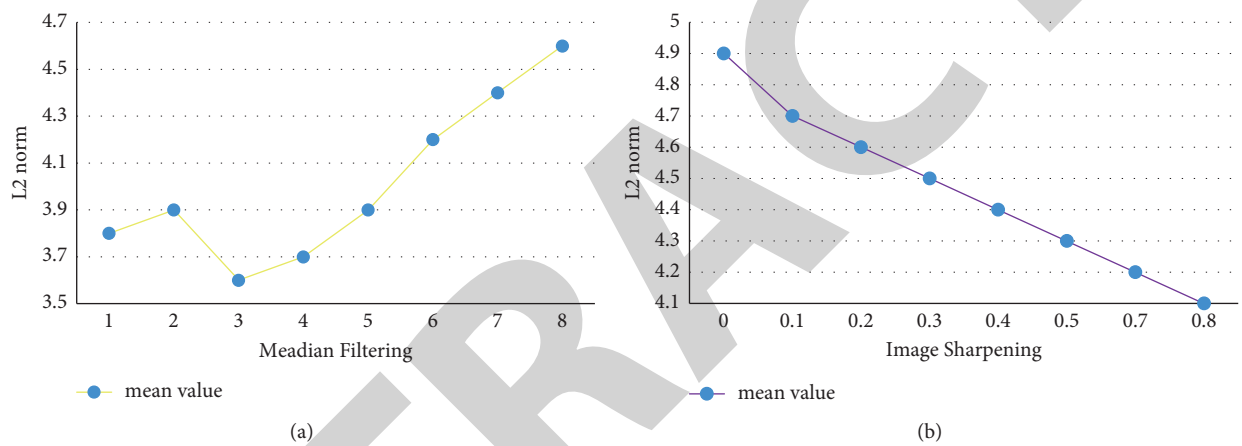

Figure 6: Robust performance of tea culture elements under motion blur and image sharpening retention. (a) Fuzzy motion. (b) Image sharpening.

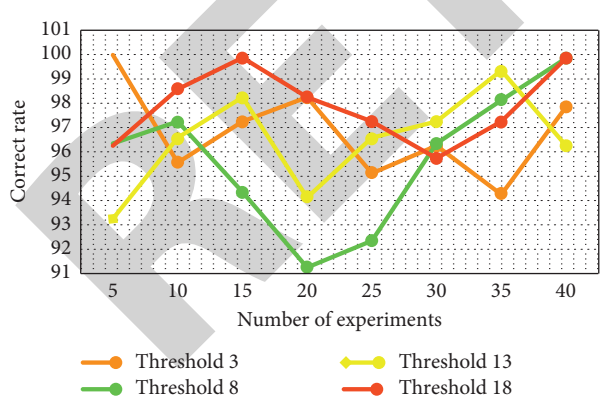

Figure 7: Detection performance of tea culture elements under different thresholds.

5. Conclusion

(1) From the perspective of the overall integration of tea culture, the understanding of tea culture in art works is the most mature. In order to make the tea culture more popular, we need to make use of the characteristics of the form of calligraphy and painting to make it a perfect carrier, so as to make up for the lack of text popularization, make the popularization of tea culture more interesting, and make the tea culture fully display its connotation in the form of calligraphy and painting.

(2) This paper studies the elements of tea culture in art works based on image perception algorithm. Under different fitting times, the average correct recognition rate of similar images and tampered images is better than ant colony algorithm and artificial intelligence algorithm. The image perception algorithm in this paper is superior to other algorithms in robustness and gender discrimination.

(3) Our algorithm also achieves reasonable performance in terms of execution time. Image perception algorithm can better publicize tea culture and improve people's love for tea culture elements in art works.

Data Availability

The figures and tables used to support the findings of this study are included within the article.

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Retraction

Retracted: Paper-Cutting Pattern Design Based on Image Restoration Technology

Security and Communication Networks

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

(1) Discrepancies in scope
(2) Discrepancies in the description of the research reported
(3) Discrepancies between the availability of data and the research described
(4) Inappropriate citations
(5) Incoherent, meaningless and/or irrelevant content included in the article
(6) Manipulated or compromised peer review

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] J. Yu, "Paper-Cutting Pattern Design Based on Image Restoration Technology," *Security and Communication Networks*, vol. 2022, Article ID 3132047, 9 pages, 2022.

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Research Article

Paper-Cutting Pattern Design Based on Image Restoration Technology

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Paper-cutting is one of the valuable intangible cultural heritages of China, with distinctive features such as "round as the autumn moon, sharp as the wheat mane, square as the green brick, missing as the serrated teeth, and thread as the beard," and is a widely spread folk art. The art of paper-cutting brings new inspiration to the design of structures, and by changing the topology of the raw material, the material/structure can undergo significant changes in physical properties, such as optical, thermal, acoustic, and mechanical aspects. The protection of intangible cultural heritage is a process of cultural self-awareness and a kind of cultural reflection and enlightenment. In the history of promoting socialist cultural development, the protection of "intangible heritage" paper-cutting is undoubtedly of great significance. The purpose of digital image repair is to restore the integrity of the broken image, and the process is to fill in the specified area of the digital image with information, requiring a natural transition between the filled area and the original area of the image and minimizing artificial traces, so that the image looks as if it has never been broken. In this paper, the paper-cutting pattern design method based on image restoration technology is investigated, starting from the preprocessing of paper-cutting images by acquiring the edges of the images and using the Criminisi image restoration algorithm with image broken edge reconstruction to realize the image broken edge reconstruction design of paper-cutting graphics. Therefore, the paper-cut graphics generated by the method in this paper are concise and coherent as a whole, which reduces the difficulty of paper-cut design while satisfying individual design requirements.

1. Introduction

In the long history of China, due to the different social divisions of labor, ordinary working people have gradually created the art form of paper-cutting using scissors in their hands [1]. The patterns prepared with the help of scissors or carving knives can give a visually pleasing impression of translucency [2]. As a kind of intangible cultural heritage fully reflecting the history of regional culture and traditional changes, paper-cutting art has cultural value, aesthetic value, economic value, and scientific and educational value, with different levels of roles and embodiments [3]. However, the international design style gives rise to the psychological pressure of monotony, tedium, indifference, and lack of human feelings [4]. Along with the development of China's economy and the growing maturity of domestic visual art design consciousness, visual art design has shifted from an elite modernist culture to a pluralistic development with the masses as the main focus [5]. However, the traditional method of designing various styles of paper-cutting patterns requires first analyzing the characteristics of the patterns and then designing specific algorithms for each pattern; not only is the workload large, but it also requires the operator to have a certain base of artistic creation to achieve [6].

In recent years, some nonrealistic drawing techniques to simulate traditional art media, such as watercolors and pencil drawings, have achieved good results, which has implications for the computer simulation of paper-cutting art [6]. The overall stiffness of the structure is reduced due to the cutout, which gives the structure better flexibility and malleable characteristics [7]. At present, the most representative image restoration techniques at home and abroad are mainly two types of partial differential equation-based restoration models and texture synthesis-based restoration

models [8]. Based on the correlation of known pixels around the area to be restored, the area to be restored is gradually filled to achieve restoration in the human eye effect according to a certain algorithm [9]. Paper-cutting gives an exaggerated, translucent, and abstract feeling visually, exaggerating the physical objects in life and reflecting their interesting characteristics, which originates from life but is higher than life and gives people the enjoyment of art [10].

As one of the most characteristic art forms of folk culture, traditional Chinese paper-cutting has become a kind of "imaginative" cultural symbol with its own unique artistic and aesthetic concepts and modeling methods through history and interpretation [11]. Paper-cutting is presented to the world as a visual carrier of traditional Chinese art, culture, and spirit [12]. The thresholding method is sensitive to algorithm parameters and easily loses details in the image, while the template-based method generates better results but relies on a large library of paper-cut templates, so it is computationally intensive and difficult to maintain the object features in the original image [13]. Therefore, the design of paper-cut patterns using image restoration techniques is also undoubtedly a way to convey traditional folk culture. It can make more people understand the art of paper-cutting and can also lead to the development of the regional economy, allowing the combination of modern and traditional to keep the design up to date [14].

The innovative points of this paper are as follows:

(1) In this paper, a broken edge reconstruction method is utilized for repairing broken images with missing important structures, where the human eye can still perceive a break at the repaired edge that is not smooth enough.

(2) This paper achieves pixel point repair according to anisotropic repair order by continuously maintaining and updating the priority of boundary pixel points throughout the repair process

(3) The article investigates the relationship between hand-made paper-cutting works and pattern design by using image restoration technology from the industry's point of view and takes the design, recognition, and matching of paper-cutting images as the research object, which is a relatively novel perspective.

2. Related Work

2.1. Paper-Cutting Pattern Design. Paper-cutting is a Chinese folk art with a long history of using common tools, simple production, and a wide variety of materials and styles. There are static window decorations and realistic shadows that can be manually controlled for dynamic performance. As a traditional Chinese cultural resource, Chinese folk art of paper-cutting, the "imagery" expression of its patterns coincides with the implications of graphics in graphic design.

Shi et al. decomposed the basic compositional patterns of images based on paper-cut patterns as the object of study, divided these patterns into independent patterns and conforming patterns, and generated new patterns by performing simple logical operations on these basic images, etc. [15]. Liang proposed a design of a computerized paper-cutting system based on a pattern library that contains patterns with many different characteristics and can be adapted to different requirements by parameter transformation in the Journal of Computer Engineering [16]. Duan and Wang analyzed the basic characteristics and structure of paper-cut patterns, classified paper-cut patterns, and studied the methods of pattern generation by using hand-cut paper as the object [17]. Xu et al. conducted an in-depth study on decorative patterns and proposed some composite pattern generation methods, such as expanded symmetrical pattern design and gradient path decoration [18]. Sayed et al. studied and analyzed paper-cutting modeling, extracted paper-cutting images out of the required basic patterns, applied genetic algorithms to pattern generation, and let the computer generate patterns automatically so that the resulting patterns are more colorful, and on this basis, also added the measures of curve uniformity and smoothness to optimize the quality of paper-cutting pattern generation [19].

Traditional Chinese folk paper-cutting patterns are created by working people to meet the needs of their own spiritual life, expressing the passionate and simple emotions of ordinary people. The choice of the pattern for the content is often based on the aesthetic ideal of praying for a better life and the pursuit of beauty to be expressed, consistent with the visual communication of the graphic. After thousands of years of inheritance and development, it has been influenced by many aspects of society and has been integrated and permeated by each other. It is not only a hand-made paper-cutting art but also contains the Chinese economy, politics, culture, life, folklore, spirituality, religious beliefs, and other nonmaterial civilization, and has become an important reference material for the study of history and culture.

2.2. Image Restoration Technology. The use of exaggerated deformation in the patterns of paper-cutting artworks makes the difference between different works of the same type of pattern, and a single characteristic parameter does not describe well the characteristics of different patterns. Nowadays, with the advent of computers, digital cameras, scanners, and other equipment, paper-cutting works are preserved in digital form, and paper-cutting has crossed over into a new field.

Yamanaka and Miyashita decomposed paper-cutting patterns by hand, created a pattern library, and selected patterns in the pattern library to be embedded in specified positions within the paper-cutting contours. The structural information specifically refers to the overall change of the image, outlining the basic outline of the image, which can be considered as a description of a larger scale [20]. The methods proposed by Yang all first segmented the image based on color or structural features and then patched the various regions into which the segmentation was made. Correspondingly, texture information represents local information details, which are generally reflected as recurring specific patterns, such as patterns [21]. Iyer accelerated the development of digitization techniques for the traditional art

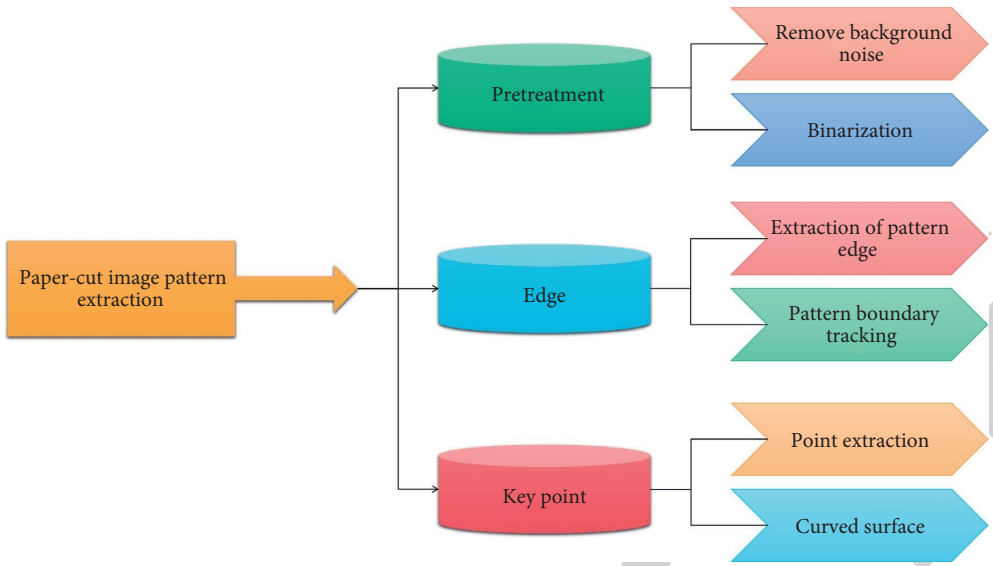

Figure 1: Pattern extraction of paper-cut image.

of paper-cutting by studying a large number of paper-cutting patterns and establishing a database of elemental symbols [22]. Chu et al. proposed an image restoration method that can repair images with overlapping structural textures and other textures, while Higashi and Kanai proposed an adaptive restoration algorithm based on CDD to address the problems of large time overhead and parameter instability in the CDD model, which model dynamically and freely restores the image based on the local feature information of the missing boundary part of the image [23]. The algorithm model dynamically and freely selects the diffusion restoration based on the local feature information of the missing boundary part of the image [24].

In practical applications, whether it is normal life or the application of high-tech occasions, the requirement for images is to provide effective information, so we need to fill in the repair of images with missing information. Based on the existing research results, the article analyzes the characteristics of hand-made paper-cutting art in depth and proposes a paper-cutting pattern design method with image repair technology to improve the above method.

3. Design Ideas of Paper-Cut Patterns Based on Image Restoration Technology

3.1. Paper-Cut Image Preprocessing. Patterns are used for decoration and the process by which they are created derives from the direct design intent of the designer, and many of them are actually the visualized product of imagery [25]. In order to preserve the integrity of flawed artistic treasures, such a group of professionals engaged in art restoration has emerged. For a realistic hand-cut artwork to become a digital image that can be stored, recognized, and processed by a computer, it is necessary to capture and store the graphic image on the computer. Data acquisition is the conversion of objects present in space into digital signals that can be stored and processed by a computer through the use of certain sensors [26]. The paper-cut image pattern extraction module is divided into three submodules: preprocessing, edge, and key point, as shown in Figure 1.

First of all, from the content of the paper-cut image, it mainly consists of the image area and background area. The interference of noise will appear in some bright spots and dark spots, which can be removed by simple mean filtering that does not affect the binarization effect of the image. The input image is lazily segmented to extract the foreground, and then the foreground is blurred to remove the high-frequency part. The image with noise removed is transferred to the computer by the image acquisition card, and the image is processed by the processes of preprocessing, character segmentation, character training, and character recognition to get the segmentation result. The segmentation can be expressed by the following equation:

$$g(x, y) = \begin{cases} 1, & \text{if } (f(x, y) \geq T) \\ 0, & \text{if } (f(x) < T) \end{cases} \tag{1}$$

T is the effect of image segmentation

Since there is no algorithm that can directly perform edge detection on color images, it is necessary to convert color images to grayscale images in advance before performing edge detection, i.e., grayscale conversion. Assume the image size is $M \times N$, and use $I_0(x, y)$ and $I_1(x, y)$ to denote the image before and after restoration, respectively, and (x, y) to denote the pixel coordinates. The mathematical expression of the mean square error MSE is as follows:

$$\text{MSE} = \frac{\sum_{x=1}^{M} \sum_{y=1}^{N} [I_0(x, y) - I_1(x, y)]}{M \times N}. \tag{2}$$

The mathematical expression of SNR is as follows:

$$\text{SNR} = 10 \times \lg \left[\frac{\sum_{x=1}^{M} \sum_{y=1}^{N} I_0(x, y)^2}{\sum_{x=1}^{M} \sum_{y=1}^{N} [I_0(x, y) - I_1(x, y)]^2} \right]. \tag{3}$$

The mathematical expression of PSNR is as follows:

$$\mathrm{PSNR} = 10 \times \lg \frac{255^2}{\mathrm{MSE}}. \tag{4}$$

In general, the edge corresponds to high-frequency information, while the flat point corresponds to low-frequency information, and the noise corresponds to high-frequency information [27]. How to distinguish the noise information in the high-frequency band is the key to keeping the edge information and removing the noise [28]. The paper-cutting patterns were constructed by using the spline curve, and then the paper-cutting images were generated by combining the patterns to obtain the paper-cutting patterns with ethnic style [29]. The paper-cutting design module consists of three parts: drawing parameter setting, common graphics drawing, and pattern drawing, as shown in Figure 2.

Secondly, the grayscale image is divided into two grayscale regions, one of which is set to 0 and the other is set to 1, so as to prepare for more accurate edge extraction. From the viewpoint of modern visual communication design, the paper-cut pattern organizes the natural objects located in a different time and place according to a clear design intention and transforms the three-dimensional world into a two-dimensional paper surface. By calculating the center-of-mass position of each color grouping, the location information of the pixels is incorporated to make the tracking more accurate and rapid. To calculate the center of mass of each color unit i:

$$K_i^n = \frac{\sum_{i=1}^{n_h} \delta[b(X_i) - u] X_i}{\sum_{i=1}^{n_h} \delta[b(X_i) - u]}. \tag{5}$$

n is the n frame image, X_i is the pixel position in the target area, μ is the histogram color value, and $b(X_i)$ is the color value of pixel.

For edge information, the pixel values of the images at these locations change drastically, and the gradients corresponding to their gray functions are larger at the edges and smaller at the nonedges of the images, where the gray scale does not change much. A suitable threshold is found to binarize the whole image, and then a concatenation algorithm of disconnected regions is used. However, when edge detection is performed, image blurring and the presence of noise can lead to a wide or broken edge somewhere. Therefore, the image is corrupted with this structural element, and then the corrupted result is subtracted from the original image to obtain the image boundary.

Finally, a threshold is determined before binarization, which is used to segment the object area and the background area after the image is filtered. To set the threshold, pixels with a brightness value greater than the threshold are set to white, and those below the threshold are set to black. Paper-cut patterns do not have light and shadow effects, but the organization of dots, lines, and surfaces, the black and white contrast of yin and yang engraving, does not lose the richness of the hierarchy and sense of rhythm, this special medium and expression of paper-cut patterns determine its flat two-dimensional modeling characteristics. A digital image often contains a wealth of information. According to the image edge characteristics to divide, we can divide these information into two parts: edge information and non edge information, in which the non edge information and the image itself containing noise points change more smoothly. For the target pixel in the binary image, if after removing it, its 10 neighboring pixels can still form a closed boundary line, and the position and shape of the boundary line are not affected, the pixel can be considered as not a boundary pixel.

3.2. Paper-Cut Pattern Design Based on Image Restoration Technology. The traditional method requires a large amount of work if various types of patterns are to be designed and requires the operator to have a certain foundation of artistic creation to achieve it. Paper-cut pattern design based on image restoration technology organizes natural objects located in a different time and place purposefully according to a clear design intention and transforms the three-dimensional world into a two-dimensional paper surface, forming a way of thinking and observation that is compatible with plastic arts. A large number of restoration models, as well as image restoration algorithms, have been proposed. Currently, there are two main representative image restoration algorithms, and the image restoration technology approach is shown in Figure 3.

First, the basic feature symbols are extracted from the existing paper-cutting patterns. In the subsequent cropping of the paper-cut pattern space, the edges of the image are cropped in one direction, counterclockwise, or clockwise. Cropping in the counterclockwise direction will keep the image part inside the edge, while cropping in the clockwise direction will crop out the area inside the edge. In general, blocks to be repaired with high confidence values should be repaired first so that the repair process is more reliable, and the confidence level is defined as follows:

$$C(p) = \frac{\sum_{q \in \psi_p \cap \varphi} C(q)}{|\psi_p|}. \tag{6}$$

$C(p)$ is the confidence level and $|\psi_p|$ is the area of ψ_p.

However, the design of paper cutouts requires a comprehensive consideration of various factors such as the lightness and darkness of pixels, the strength of edges, and the overall connectivity, etc. The threshold-based approach to determining the skeletonization property of each pixel based only on the lightness and darkness of pixels is obviously not in line with the artistic characteristics of paper cutouts. So it is an essential process for image extraction. Because the gradient reflects the degree of the color change of pixel points, the gradient magnitude of all known points in the block to be repaired can represent the structural information of this region to a certain extent. Therefore, in the patching, it is only necessary to implement the patching in the direction of the iso-illumination line, and whether the gradient rotation direction is clockwise or counterclockwise does not have a significant impact on the patching effect, but only needs to ensure the direction of change of the minimum gray value. The bilateral filtering kernel is constructed by multiplying a Gaussian kernel function in the null domain

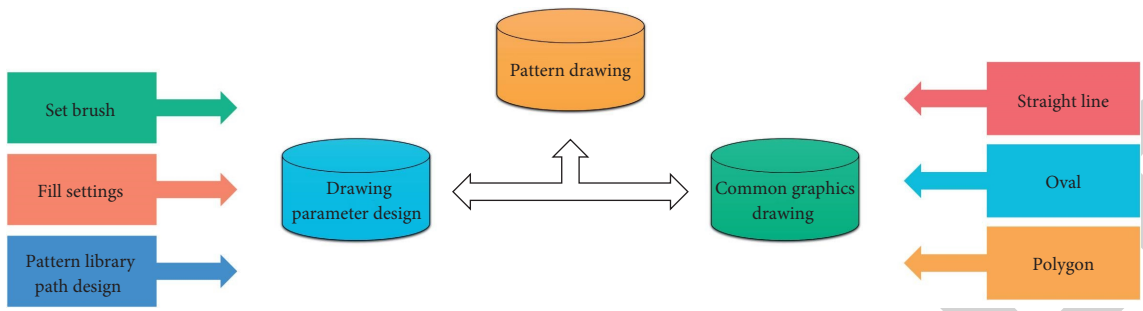

Figure 2: Paper-cutting design process.

(spatial Gaussian kernel) with a Gaussian kernel function in the value domain (luminance Gaussian kernel):

$$g(x) = \frac{1}{C_{d,\gamma}} \sum_{x,y\in\Omega} w_d(x,y) w_r(x,y) f(x). \tag{7}$$

$f(x)$ is the original image, $g(x)$ is the output image, $w_d(x,y)$ is the spatial information weight function, and $w_r(x,y)$ is the gray similarity weight function.

Therefore, the position of the center of the local neighborhood is continuously shifted with the distribution of the initial samples until the entire iterative process ends when the position of the center hardly changes anymore.

$$C(p) = C(\hat{p}), \forall q \in \psi_p \cap \varphi. \tag{8}$$

$\hat{p}$ is the center point of the new block to be repaired.

Image edge tracking is to use the edge connectivity to arrange the closed curves of individual edges in one direction counterclockwise or clockwise, pixel by pixel, and store the position of each pixel, i.e., the horizontal and vertical coordinate values. The gray number of the image is divided into 2 parts by gray level, and the optimal threshold is found by calculating the maximum value of variance between classes so that the difference in gray value between the two parts is maximized:

$$p_i = \frac{n_i}{N}, \quad (i = 0, 1, 2, \ldots, L), \qquad \sum_{i=0}^{L} p_i = 1. \tag{9}$$

N is the total number of image pixels, n_i is the number of pixels with gray level i, and p_i is the probability of gray level i in image.

The subsequent repair process relies on nonlinear diffusion so that those colors that are randomly filled in the defaced area can appear in contrast with the surrounding area by diffusion. The direction of the maximum gray change in the image corresponds to the gradient, while the direction of the minimum change in gray is perpendicular to the gradient. By simply changing the operators of $C(p)$ and $D(p)$ to summation and introducing the weights α, β for weighting, respectively, the improved priority calculation formula is as follows:

$$P(p) = \alpha C(p) + \frac{1}{\beta} D(p), \tag{10}$$

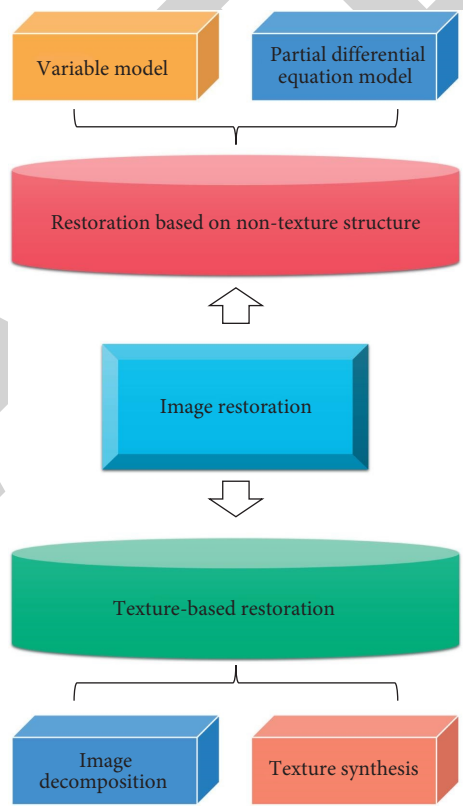

Figure 3: Image restoration techniques and methods.

$D(p)$ the data item.

Finally, the basic graphic elements are decomposed from the paper-cut pattern, and the graphic elements that do not exist in the existing pattern are generated based on these graphic elements. It obtains the coordinate value of a pixel in a certain direction by adding the coordinate value of the center pixel to the offset corresponding to that direction so as to realize the traversal and judgment of this pixel value. In other words, iterations occur at the edge pixels of the waiting repair area, and the actual update area advances one pixel in the waiting repair area with each iteration. If the number of nonzero elements in the signal is much less than the number of zero elements, the signal is said to be sparse. And in reality, generally, natural signals are not sparse. However, we can perform a sparse representation of the signal in the overcomplete dictionary to get an approximate sparsity.

After each image restoration, we have to run the anisotropic diffusion several more times, and in this way, we keep the correctness of the information transfer at the boundary of the broken region and reach the smoothness of the image edges.

4. Application and Analysis of Image Restoration Technology in Paper-Cut Pattern Design

4.1. Analysis of the Criminisi Image Inpainting Algorithm. The Criminisi algorithm introduces the concept of repair priority for the first time and uses the structural information of the image as a reference for the image repair order, making the repair order of the algorithm more reasonable. If the graphic elements are replaced, or curve fitting is used, a large number of paper-cut patterns of various forms can be generated. The advantage of curve fitting is that the more complex curves can be obtained by giving enough control points. An example of curve fitting is shown in Figure 4. The ordinate in Figure 4 is the peak signal-to-noise ratio: the ratio of the maximum possible power of the signal to the destructive noise power that affects its representation accuracy.

Based on the edge information of the area to be repaired, the information from the known area of the image is diffused into the area to be filled along the direction of the iso-illumination line and using the diffusion mechanism. In other words, in the image restoration process, several iterations of diffusion should be performed for each restoration step, and the diffusion is to avoid curve crossings. Each diffusion process fills the data information generated by the previous diffusion into the broken area, and then the global statistics of the filled image are performed using a Bayesian model. It is used to estimate the next diffusion coefficients and generate new data for the next iteration based on the new diffusion coefficients until the image restoration is completed. The PSNR values and restoration times of the Criminisi algorithm were compared with the TV model restoration and the FMM algorithm restoration, and the results are shown in Table 1.

Next, the priority of the block to be repaired, determined by all pixel points on the broken edge, is calculated according to the priority formula defined by the algorithm, and then the block with the highest priority is selected by comparison as the starting block for image repair. In the pure white initialization, there is no information in the area waiting to be repaired, and the gray value of each point in the replacement area needs to be gradually passed through the points at the edge location of the area, which is obviously very unfavorable to the repair work. Therefore, not only the confidence term is considered when calculating the priority, but also the weight coefficient is added. The size of the weight coefficient is related to the iso-illumination line of the points at the edge of the region to be repaired, and the iso-illumination line can represent the propagation of the structural information (Figure 5).

Since the change of image gradient reflects the change of image spatial frequency, i.e., it can reflect the local characteristics of the image, the sample block size is determined adaptively according to the gradient value size. However, since the selection is based on the sum of the smallest equal illumination lines, if the defective area contains relatively thin lines, it is likely to be truncated during the restoration process, thus destroying the visual connectivity principle. So the atoms found by traversing the dictionary in each iteration with the highest similarity to the signal are orthogonalized, and such an operation avoids repeated selection of atoms in the image and improves the accuracy of the priority solution.

Finally, a global search is used to find a matching block within the known region that is most similar to the texture

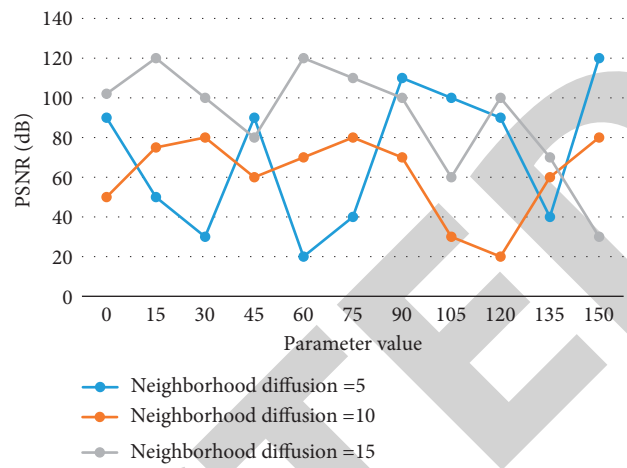

Figure 4: Example of curve fitting.

Table 1: Comparison of PSNR value and repair time of different algorithms.

	Criminisi	TV	FMM
PSNR	24.987	31.255	45.982
Repair time	1.98	1.65	0.47

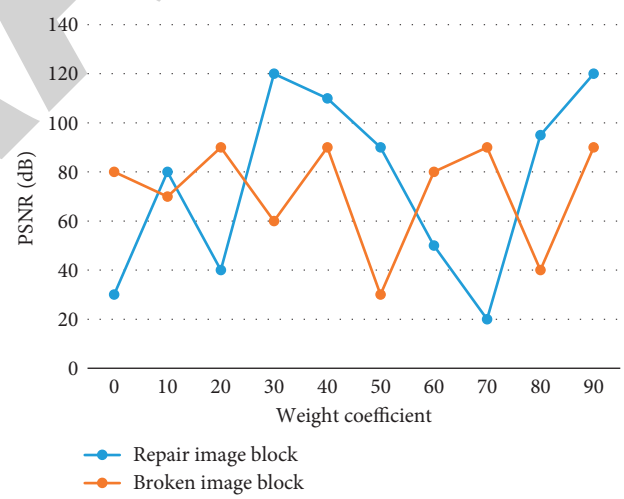

Figure 5: Comparison of PSNR values.

information of the block to be repaired using the SSD matching criterion, and then the corresponding pixel information in that block is copied and filled into the block to be repaired. The pure white initialization prompts the individual points within the rest to have all 0 propagation, and it is only the points waiting for the edge locations of the repaired region that can rely on the residual information to get the propagation and further update the values. The digital image restoration process is mainly to keep the edge information as much as possible while restoring the image, try to keep the rate of change of the image edge in the gradient direction during the image smoothing process, and try to make a large smoothness in all directions at the nonedge points so that a good repair of the broken image can be achieved.

4.2. Analysis of Image Damaged Edge Reconstruction. To obtain good image restoration results, it is necessary to first constrain the restoration of image structure information, i.e., to connect and continue the image edge information accurately and effectively and to ensure that the part to be restored with significant structural features can be restored first.

First, as an important basis for fracture point matching, the color feature mainly describes the color composition of the neighborhood of the defective region, while the curvature information describes the extension direction of the defective structure of the image. Priority is given to repairing structural information and information in the vicinity of structural regions. Before repairing a broken image, an anisotropic smooth diffusion of that image is performed in advance, with the purpose of eliminating the effect of noise on the whole repair process, after which the alternating cycle of repair and diffusion is entered. The texture of the image, especially the texture to be filled in the area to be repaired, is a very irregular texture, which is relatively messy. Therefore, we want to add the amount of information in the area to be repaired and give the initial values to the internal points, thus increasing the iteration speed with a large number of points getting the conductivity and expecting to improve the repair effect. Instead of deciding pixel by pixel whether to skeletonize or preserve, the paper-cut pattern generation task calculates the skeletonization properties of each segmented region, i.e., whether to skeletonize the whole. A comparison of the feasibility of the algorithms in this paper is also performed using 20 sets of images from the OTB-2020 dataset, where the comparison algorithm is CSK. Finally, the tracking accuracy graph shown in Figure 6 and the tracking success rate graph shown in Figure 7 are obtained.

Secondly, the isolated fractured edges without matching edge lines are then extended naturally according to their curvature until they intersect with known regions or reconstructed edge lines. That means the smaller the value of the data term and gradient term in the priority, the easier it is to get a good repair effect. In the image restoration process, the good or bad image edge combination directly affects the quality of image restoration, and the biggest advantage of overall variation is that it overcomes the shortcomings of

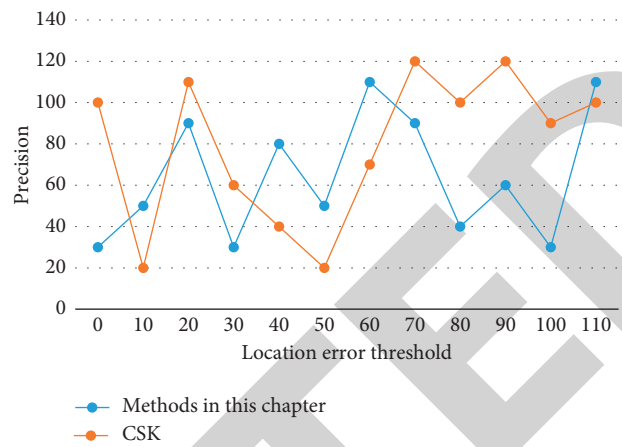

Figure 6: Comparison chart of ope accuracy.

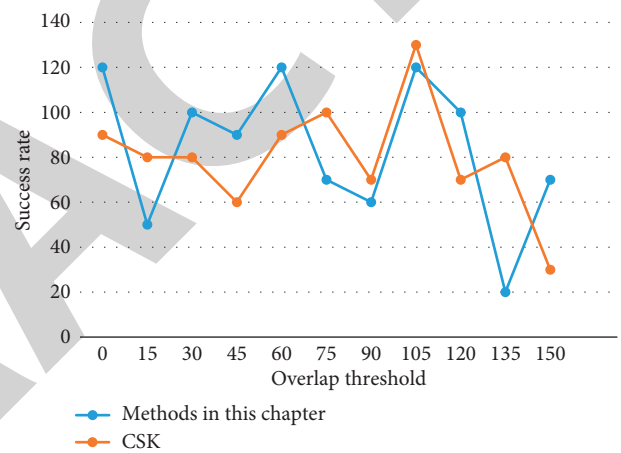

Figure 7: Comparison chart of OPE success rate.

linear filtering in suppressing noise while smoothing image edges, which does not change or sharpen image edges while suppressing noise. At the same time, if there are fewer known points in the target block, i.e., the smaller the confidence term, the less edge information it contains and the easier it is to match. If the skeleton properties of adjacent regions are different, the boundary between them will be preserved in the final cutout figure. The running time of image broken edge reconstruction, CDD algorithm, and FMM algorithm are compared, and the results are shown in Table 2.

Compared with the CDD and FMM algorithms, the image broken edge reconstruction lengthens the runtime by 27.7 s and 38.5 s. Both MSE and PSNR are well improved, indicating that the image broken edge reconstruction effectively improves the restoration results while running fast.

Finally, the process of edge reconstruction is consistent with the process of curve fitting, which is the process of connecting mutually independent points with a smooth curve, i.e., estimating the trend of the curve using the few known information around the broken edge. A paper cutout has only two colors, while the input image contains thousands of colors. Unlike sound and text, images have a more

Table 2: Reconstruction of the damaged edge of the image, comparison of running time between MSE algorithm and PSNR algorithm.

Parameter	FMM	CDD	Image damaged edge reconstruction
Run time (s)	17.7	28.5	56.2
MSE	0.1173	0.1182	0.2673
PSNR (dB)	57.10	59.36	62.88

visual representation, so they can be said to be the most objective reflection of things. For images, the lower the priority, the higher the chance of matching the target block successfully and the better the repair effect, so choose to repair the block centered on the point with the lowest priority each time. In the process of image restoration, the overall variance model can be used to preserve the edge information of the image while minimizing the total variance of the image to achieve the restoration of the degraded image. To transform an image into a paper cutout, it is actually a matter of determining whether to take the foreground color or the background color for each segmented region. Therefore, the image can be converted into a grayscale image by color quantization, and finally, the image is converted into a binarized image suitable for system processing. The edge reconstruction takes into account the continuity of the structural information of the edges of the broken areas in the image and the preservation of the texture information while repairing the broken areas, which ensures the natural texture and structural coherence of the broken areas after the image repair.

5. Conclusions

(1) Chinese traditional folk paper-cut patterns are created by working people to meet the needs of their own spiritual life and express the passionate and simple feelings of ordinary people. It is not only a kind of manual paper-cut art but also contains China's economy, politics, culture, life, folk customs, spirit, religious beliefs, and other intangible civilizations. It has become an important reference for the study of history and culture. Based on the existing research results, this paper deeply analyzes the characteristics of manual paper-cut art and puts forward a paper-cut pattern design method that uses image restoration technology to improve the above methods.

(2) Image restoration is actually a process of filling the damaged part with the known information in the image and obtaining the results that conform to the human visual characteristics through certain methods. This paper presents a paper-cut pattern design method based on image restoration technology and analyzes the reconstruction of image broken edges by the classical Criminisi algorithm based on texture synthesis. The algorithm not only makes the information near the area to be repaired diffuse inward according to the isoilluminance line so as to repair the image but also effectively balances the noise while ensuring the image edge. Edge reconstruction considers the continuity of the edge structure information of the damaged area in the image and preserves the texture information when repairing the damaged area, which ensures the natural texture and structure consistency of the damaged area after image repair.

Data Availability

The data used to support the findings of this study are included in the article.

Conflicts of Interest

The author declares that there are no conflicts of interest.

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