

Retraction

Retracted: Early Warning Method of Postgraduate Education Quality in Colleges and Universities Based on Multisource Information Fusion

Wireless Communications and Mobile Computing

Received 27 June 2023; Accepted 27 June 2023; Published 28 June 2023

Copyright © 2023 Wireless Communications and Mobile Computing. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1].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] Y. Xu, X. Zhou, W. Qi, and J. Wu, "Early Warning Method of Postgraduate Education Quality in Colleges and Universities Based on Multisource Information Fusion," *Wireless Communications and Mobile Computing*, vol. 2022, Article ID 1888731, 10 pages, 2022.

Research Article

Early Warning Method of Postgraduate Education Quality in Colleges and Universities Based on Multisource Information Fusion

Yue Xu,¹ Xiaorui Zhou¹,^{ORCID} Wanxia Qi,¹ and Jialing Wu²

¹Business School Chengdu University, Chengdu, Sichuan 610106, China

²School of Educational Sciences, Sichuan Normal University, Chengdu, Sichuan 610000, China

Correspondence should be addressed to Xiaorui Zhou; zhouxiaorui@cdu.edu.cn

Received 19 June 2022; Revised 28 July 2022; Accepted 2 August 2022; Published 16 August 2022

Academic Editor: Mohammad Farukh Hashmi

Copyright © 2022 Yue Xu et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the rapid development of postgraduate education in my country, the contradiction between its quantitative growth and quality improvement has become increasingly prominent. At the same time, due to the downward shift in the focus of postgraduate education management, the role of provincial governments in the reform and development of postgraduate education has become increasingly important. Therefore, strengthening the practice of quality supervision and evaluation of postgraduate education at the provincial level is not only a realistic result of the development of postgraduate education in my country but also an inevitable requirement for the further development of postgraduate education in my country in the future, which has an important theoretical and practical significance. With the rapid development and wide application of computer network technology, communication technology, and multisensor technology, multisource information fusion has been selected by many colleges and universities as a method to evaluate the quality of postgraduate study because of its closeness to the frontier of disciplines. Therefore, how to effectively improve the teaching quality of multisource information fusion courses is a practical problem that needs to be solved urgently, and the improvement of teaching quality is also a key factor affecting the comprehensive quality of students. This paper deeply analyzes the setting and requirements of the information fusion course, combines the characteristics of mathematical theory and tools in information fusion, uses multisource data to model student behavior, and proposes a serialized prediction framework based on a deep network. The network structure reasonably integrates multisource data and automatically extracts behavioral characteristics. Combined with the static characteristics of students, the paper uses the long-term and short-term memory network to model the overall online behavior of students and finally predicts the probability that students have academic risks. The model is tested on a real university course dataset, and the experimental results show that the performance of the proposed algorithm is better than the baseline comparison algorithm.

1. Introduction

In recent years, due to the rapid development of higher education in my country and the continuous expansion of the demand for high-level professional talents due to social development, the types of postgraduate education in my country have become increasingly diverse, the forms have also been continuously enriched, and the overall scale has continued to expand [1]. In the 70 years since the founding of new China, China's graduate education has achieved a historic leap. The degree system has grown from scratch,

and the scale of education has grown from small to large. A graduate education system with relatively sound systems, reasonable scales, and basically complete categories has been basically formed. This is also the 70 years of rapid development of graduate education research, and different scholars at different stages have made contributions. However, with the rapid development of postgraduate education, the contradiction between its quantitative growth and quality improvement has become more and more obvious, and it has become the focus of postgraduate education reform [2]. Figure 1 shows the changes in the proportion of various

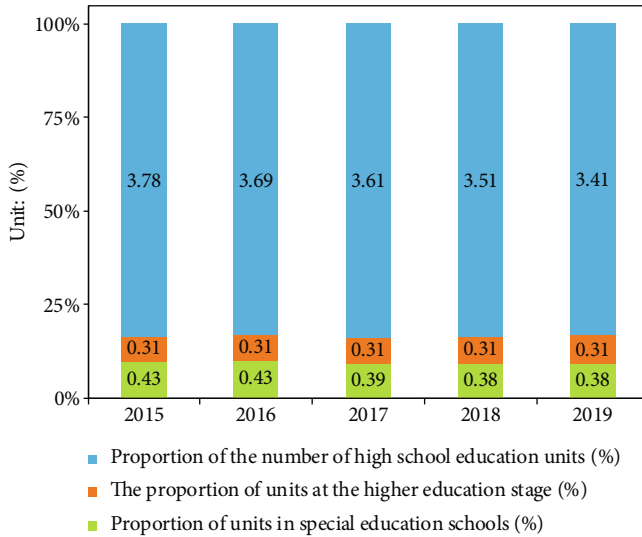


FIGURE 1: Changes in the proportion of the number of various educational units in China from 2015 to 2019.

educational units in China from 2015 to 2019. The “Opinions on Deepening the Reform of Postgraduate Education” (Jiaoyan [2013] No. 1) issued in 2013 pointed out: “strengthen the quality assessment of postgraduate education,” and emphasized “increase local coordination and expand the autonomy of training units,” “accelerate the construction of a quality supervision system led by the supervision of education administrative departments,” and “strengthen the main role of training units in quality assurance”; “Opinions on Strengthening the Construction of Degree and Postgraduate Education Quality Assurance and Supervision System” issued in 2014 (Degree [2014] 3) also pointed out: “take the road of connotative development and improve the quality of postgraduate education” [3]. At the same time, due to the continuing reform of the postgraduate education management system and the decentralization of degree management rights, the focus of postgraduate education management in my country has gradually shifted downwards, and the role of provincial governments in the reform and development of postgraduate education has become more and more important [4]. It can be said that the practice of strengthening the quality supervision and evaluation of postgraduate education at the provincial level is not only a realistic result of the sustainable development of postgraduate education in my country but also an inevitable requirement for the further development of postgraduate education in my country in the future. The reform has theoretical and practical significance [5]. However, the existing researches on the quality evaluation of postgraduate education in China are basically carried out for individual colleges and universities or a certain discipline, and most of them focus on the design of macroscopic evaluation index systems, and lack of specific evaluation methods for provincial postgraduate education. Quality assessment of relevant studies. Therefore, from the perspective of provincial postgraduate education evaluation, a set of quality measurement and monitoring and early warning models are constructed to comprehensively examine and diagnose postgraduate educa-

tion [6]. It is suggested that it is one of the indispensable works for the future provincial postgraduate education to take the path of connotative development. This is the starting point of this study [7].

Today, our society has entered the information age in an all-round way. Information technology is one of the fastest-growing high-tech technologies and has become an important engine for my country’s economic growth [8]. The role played by various related fields of information technology in the development of strategic emerging industries will directly affect the development process of my country’s strategic emerging industries [9]. To cope with this situation, multi-source information fusion emerges as a new frontier subject and research field [10]. The purpose of multisource information fusion is to make full use of multisensor information resources in different times and spaces and to analyze, interpret, and describe the measured object according to the obtained multisensor observation information under certain criteria, so that the system can obtain more than each component. Better performance [11]. As an intelligent information processing technology, multisource information fusion technology has been widely used in civil fields such as industrial robots, air traffic control, environmental monitoring, diagnosis, and maintenance of complex systems [12]. The future trend of multisource information fusion technology is to organically combine intelligent technologies such as D-S evidence theory, fuzzy theory, neural network, and Bayesian method and apply them to practical information fusion problems, which will be an important research direction and development trend in the future. However, the multisource information fusion technology has not been fully reflected in the teaching plans of colleges and universities, because the domestic research on the field of information fusion started relatively late, and there are few monographs and reference books related to this field. In addition, most of the people engaged in this field are military industry, scientific and technological workers in research institutes, and engineering technicians in production design [13]. Therefore, they have a great demand for the study and research of multisource information fusion [14]. As a reserve army for future research in this field, college students have little knowledge of the basic theoretical knowledge involved in multisource information fusion technology, and at the same time, there is a serious lack of related research and practical skills [15].

On the subject of early warning and analysis of students’ teaching quality, most of the current research is limited to analyzing the behavioral data left by students on relevant course education platforms [16]. Through the mining of learning behavior data such as students browsing and editing different pages, participating in forum discussions, etc., managers can more objectively understand students’ learning paths [17]. But at the same time, there are also a lot of effective data that have not been fully utilized [18]. For example, students’ online learning behavior is also affected by their own Internet habits and other external factors [19]. Therefore, students’ daily web browsing behavior is also an important factor affecting students’ teaching quality; the reasonable integration of students’ multisource online data has become a key step to more comprehensively grasp the students’ learning status [20–22].

Through comprehensive mining of online behavior characteristics of students, a more accurate and timely early warning can be given to students with low risk of scoring, and the accuracy of prediction can be improved.

2. State of the Art

2.1. Research on the Concept of Postgraduate Education Quality. What is the quality of education? The popular explanation is that people's subjective consciousness of judging the educational effect or the quality of education is an evaluation of education, either positive or negative. Schools and educators have a significant effect on the education of students and can achieve the expected goals, which is the basic standard for evaluating the quality of education. The quality of education takes the educated as the basic main body. Students can successfully complete their studies through the education of schools and teachers and achieve excellent results. This is the excellent quality of education. By imparting knowledge or experience to the trainees, schools or training institutions become people who are useful to the society and become talents with social, economic, and life needs, which is the quality of education. Postgraduate education, that is, through training, makes postgraduates meet the needs of economic and social life. The "Annual Report on the Development of China's Academic Degrees and Postgraduate Education" assesses the quality of postgraduate education mainly from three aspects: first, the quality of personnel training, second, the quality of scientific research results, and third, the training units meet the needs of society. From these three aspects, the connotation of postgraduate education quality, the direction, and the measurement standard of postgraduate personnel training can be clarified. The quality of postgraduate education must follow the law of scientific development, based on the training unit's own conditions, and cultivate talents in a targeted and purposeful manner according to social needs. In addition, the quality of postgraduate education must pay more attention to the current and future academic needs, as well as the individual needs of talent training. At the same time, the quality of postgraduate education does not only refer to the quality of educational products but also clarifies the quality of educational services and the quality of teachers. The teachers can be considered from the following factors: scientific research equipment, scientific research funds, mentor team, academic atmosphere, research resources, subject resources, etc.

2.2. Postgraduate Education Quality Assurance System. The term "quality assurance" originated in the middle of the last century and was first popular in the United States, where it is well used in the business and social circles. It can be seen that the so-called quality assurance, as the name implies, is the commitment made by the manufacturer or producer to the quality of a product or service provided by the consumer, and its purpose is to make consumers more assured and satisfied. This quality assurance is not only the organization's commitment to products and services but also the user's trust in products and services. At the end of the last century, quality assurance broke through the exclusiveness of the business world and was first introduced in the UK and suc-

cessfully applied to the field of education. Since then, the term quality assurance has blossomed all over the world in the field of education, setting off a wave of higher education assurance movement. Quality assurance is a branch of quality management and is the degree of trust given to users in order to meet certain quality requirements. Conceptually, it is a part of quality management, which is the degree of trust provided in order to achieve certain quality requirements. It can be understood as a planning activity to provide products or services. The so-called education quality assurance is a guarantee or commitment of an educational institution to the educational content, educational level, educational effect, and intended purpose provided by an educational institution. Its purpose is to improve and enhance the level and quality of educational services. The quality assurance of postgraduate education is the guarantee of the educational service level and expected effect specifically for postgraduates. Ensuring the quality of graduate education is a systematic project, and the educational administrative department should strengthen supervision. Only when the administrative departments of education, degree awarding units, tutors, and other responsible subjects work together and earnestly assume their respective responsibilities can we keep the life-line of ensuring the quality of graduate education and cultivate a large number of high-level talents with both political integrity and ability for the development of the cause of the party and the country. Its ultimate goal is to ensure that students who have received postgraduate education can meet the needs of society and at the same time can meet the individual needs of postgraduates and academic research needs, and these achievements can be recognized and trusted by the society. Therefore, in the process of cultivating postgraduate talents, the construction, functions, hardware and software resources, teachers, and research and development funds of the training institutions must be excellent in all aspects, so as to ensure that the postgraduate talents cultivated are recognized and trusted by the society. The establishment and implementation of this system require the corresponding security agencies or unit organizations to implement. It cannot be regarded as a type of mechanism, but an educational activity, which is implemented through the development of activities or behaviors through its internal evaluation standards. Even many western developed countries provide protection for higher education through legal standards. From this, it can be concluded that the establishment and improvement of this system are based on improving the quality of postgraduate education, based on the core culture, and the government, society, and schools jointly constitute the integrity of the security system. The advantages of the three complement each other and can be fully utilized. With their respective strengths, the postgraduate education guarantee work can be carried out in an orderly manner and play its due role.

2.3. The Importance of Improving the Quality of Postgraduate Education. As the top of the national education system, graduate education is the main way to cultivate high-level talents and release talent dividends. It is an important pillar of national talent competition and scientific and technological competition.

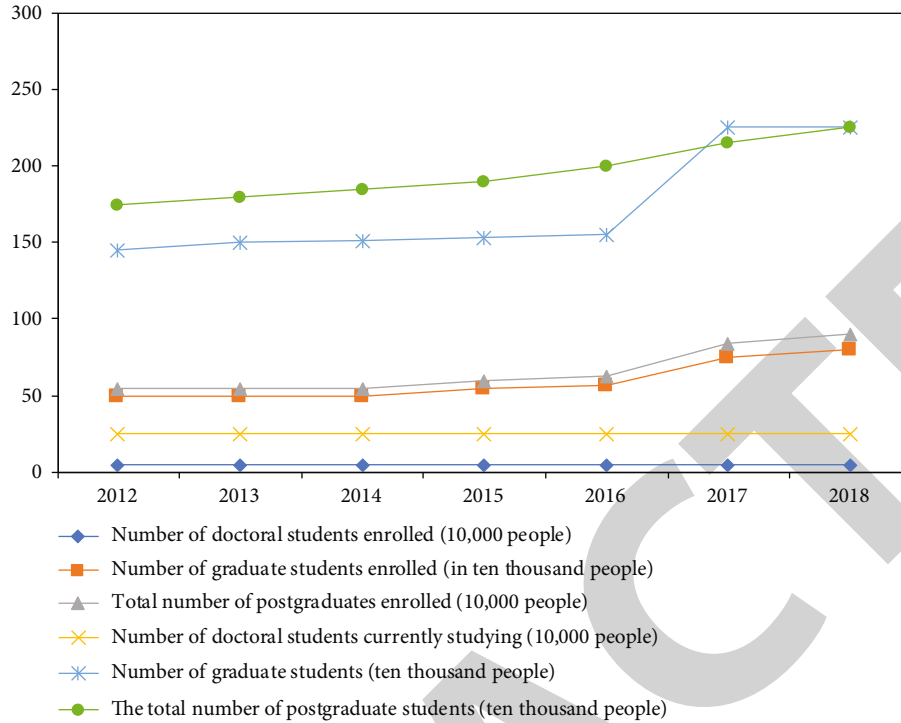


FIGURE 2: My country's postgraduate enrollment and number of students in recent years.

It is the core element of implementing the innovation-driven development strategy and building an innovative country. It is an important combination of the first productivity of science and technology, the first resource of talents, and the first driving force of innovation. In recent years, my country's postgraduate training institutions continue to emerge. According to data from the Ministry of Education, in 2018, there were 815 postgraduate training institutions located all over the country. Ordinary colleges and universities only account for two-thirds, with about 580 training points, 235 of which are in scientific research institutions. The overall number of graduate students has reached 2.7313 million. At present, due to the implementation of the enrollment expansion policy, the number of graduate students enrolled each year also shows a trend of substantial growth. The number of students enrolled in 2011, 2014, and 2018 was 560,200, 621,300, and 858,000, respectively. As shown in Figure 2, the growth of data shows that more and more people have joined the postgraduate team. The number of postgraduate students in my country has reached a certain scale and has caught up with the international education powers. Because of this, my country's postgraduate education is also facing challenges. The training methods of postgraduates should be more diversified and standardized, and the scale and development should be paid more attention to in recruiting students, so as to lay an important foundation for the high-quality development of postgraduate education and accelerate the development of postgraduate education. The pace of transformation to an educational powerhouse.

The construction of a talented country and higher education are inseparable. Higher education not only improves the quality of the public but also makes great contributions to cultivating high-level talents with an innovative spirit. The power

of talents is reflected in the power of quality, but also the power of excellent quality, not just the power of numbers. The realization of this goal needs to rely on the overall improvement of the quality of postgraduates. Therefore, in recent years, more and more experts and scholars have conducted in-depth research and exploration in the direction of methods and measures to improve the quality of education, in order to find an appropriate method to build an internal guarantee system for the quality of education to ensure the level of teaching. The establishment of a scientific and reasonable security system can realize all-round management and control of the level of postgraduate education and can also contribute to the construction of social modernism and provide a feasible guarantee for the great rejuvenation of the Chinese nation. The evaluation of graduate education quality covers a relatively wide range. From the existing research, it is mainly carried out around the improvement of graduate quality. The evaluation indicators generally include enrolment selection, tutor guidance, course teaching, academic training, dissertation, and management system. It can be seen that the current quality evaluation is more prominent in the training process and academic attributes of graduate students. Therefore, relatively speaking, this type of quality evaluation is not only favoured by the government evaluation but also valued by colleges and universities. It is an important content of self-evaluation of colleges and universities.

3. Methodology

3.1. Multisource Data Fusion Technology. Multisource data fusion technology refers to the technology of using relevant means to integrate all the information obtained from

investigation and analysis, evaluate the information uniformly, and finally obtain unified information. The purpose of this technology is to synthesize various different data information, absorb the characteristics of different data sources, and then extract unified, better, and richer information than single data. Inspired by the field of NLP, the traditional method of learning behavior sequence features usually uses the bag-of-words model (BoW), which takes the frequency of behaviors within a time window as the feature of behavioral sequences. Effects of sparsity issues. Another method of sequence feature learning is to represent the behavior sequence within a certain time window as a low-dimensional vector. The KimCNN used is a typical CNN structure, which has been successfully applied in the fields of computer vision and NLP sentence feature learning.

Specifically, we obtain a feature c_i from the submatrix V_{i+l-1} in the following way:

$$c_i = f(h * v_{1:i+l-1} + b), \quad (1)$$

where f is the nonlinear function, $*$ is the convolution operation, and b is the bias parameter. After applying the convolution kernel to each possible position of the behavior vector, the following feature set:

$$c = [c_1, c_2, \dots, c_{n-l+1}], \quad (2)$$

is obtained.

Then, go through a max pooling layer to get the most salient features:

$$\tilde{c} = \max \{c\} = \max \{c_1, c_2, \dots, c_{n-l+1}\}. \quad (3)$$

We can use multiple convolution kernels (with possibly different window sizes) to obtain multiple features. These features are spliced together as the final feature of the behavioral sequence.

3.2. Imbalanced Data Classification Research. Imbalanced data classification is when some classes in a dataset have far fewer samples than other classes. The class with a small number of samples is the minority class, and the class with a large number of samples is the majority class. The phenomenon of sample imbalance exists in many scenarios and applications, such as network intrusion detection data and medical diagnosis case data. Also in educational data, if only traditional classifiers are used without any processing, the majority of classes will be overwhelmed and usually more difficult to handle. For the important minority class, no effective classification effect can be obtained. Supervised generative models can inherently also be used for single-class learning, such as autoencoders and generative adversarial networks.

3.2.1. Autoencoders. Autoencoders are a type of unsupervised learning that can be used for data compression or feature extraction. This kind of network tries to align the input with the output and usually consists of two parts, an encoder and a decoder. A classic autoencoder consists of a feedforward fully connected neural network, where the input and output layers have the same number of neurons, and there

are fewer neurons in the hidden layer than in the input and output layers. The function of the autoencoder is to turn the input into a hidden space representation, which can be represented by an encoding function as

$$h = f(x). \quad (4)$$

And the decoder is aimed at reconstructing its input from this hidden representation with noise removed. The decoding function can be expressed as

$$r = g(h(x)). \quad (5)$$

Classical autoencoders based on feedforward neural networks are often used for nonsequential data. In order to be suitable for time series data and extract the sequence representation vector, Malhotra et al. proposed an autoencoder scheme based on a recurrent neural network. In an encoding RNN, the hidden state at the current time depends on the previous time state and the input at the current time, i.e.,

$$h_t = f(h_{t-1}, x_t). \quad (6)$$

The decoding phase can be seen as the inverse process of encoding, using the representation of the current hidden state and the predictions from the previous time step to reconstruct the time series:

$$y_t = g(y_{t-1}, s_t, C). \quad (7)$$

RNN-based autoencoders are trained to reconstruct the original time series. The model is trained by minimizing the squared difference of the reconstructed sequence from the original sequence.

3.2.2. Generative Adversarial Networks. The discriminator model D is a binary classifier that can predict whether the input is a real sample or a fake sample generated by the generator $G(z)$. Therefore, the objective function of discriminator D is defined as

$$\max_D V(G, D) = E_{x \sim P_{\text{deva}}} [\log D(x)] + E_{z \sim P_z} [\log (1 - D(G(z)))], \quad (8)$$

where $D(\cdot)$ outputs the probability that the input sample is the real data rather than the generated sample. G is trained by tricking the discriminator so that it cannot distinguish the generated data from the real data. Therefore, the objective function of G is defined as

$$\min_G V(G, D) = E_{z \sim P_z} [\log (1 - D(G(z)))]. \quad (9)$$

In general, GAN is a process in which the discriminator and the generator play against each other. The overall objective function is defined as

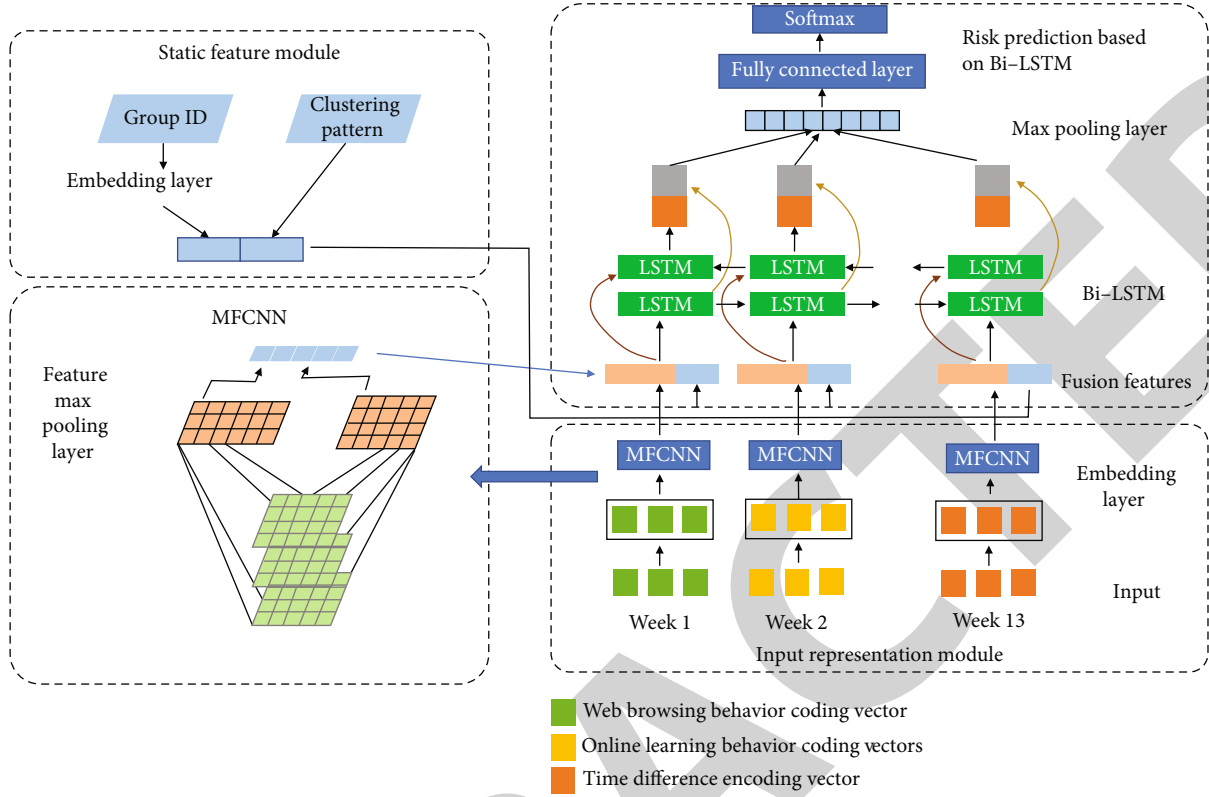


FIGURE 3: SPDN model architecture.

$$\min_G \max_D V(G, D) = E_{x \sim p_{\text{avo}}} [\log D(x)] + E_{z \sim p_z} [\log (1 - D(G(z)))]. \quad (10)$$

3.3. Memory Network. Memory network column improves the problem that the RNN memory is too small to store long-term memory. At the same time, the model applies the attention mechanism to find the historical data segments that are most relevant to the input. Through the attention weight, the end user can intuitively analyze the historical segments of different periods. The importance of the model improves the interpretability of the model to a certain extent. Initially, the memory network was applied to the question answering system, which mainly included the memory module m and the following four modules:

Input module (I) is used to convert the input to the intrinsic vector of the network:

$$x \longrightarrow I(x). \quad (11)$$

Update module (G) updates the memory module, in its simplest form inserting the output of the input module directly into the memory module:

$$m_i = G(m_i, I(x), m). \quad (12)$$

Output module (O) combines the input to extract the appropriate memory from the memory module and returns a vector, representing the completion of an inference process:

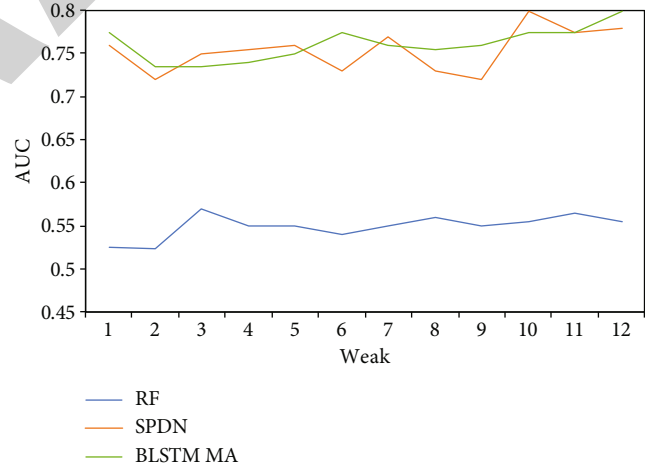


FIGURE 4: The average AUC of each model when accumulating behavior sequences of different weeks as input in early warning.

$$o = O(I(x), m). \quad (13)$$

Response module (R) converts the output vector back to the desired format, such as text or answer:

$$r = R(o). \quad (14)$$

Then, the problem q is also encoded into a problem embedding vector u_i with the same dimension as m_i , and then, the matching degree of the two vectors of m_i and u is obtained by calculating the dot product. After normalization by the

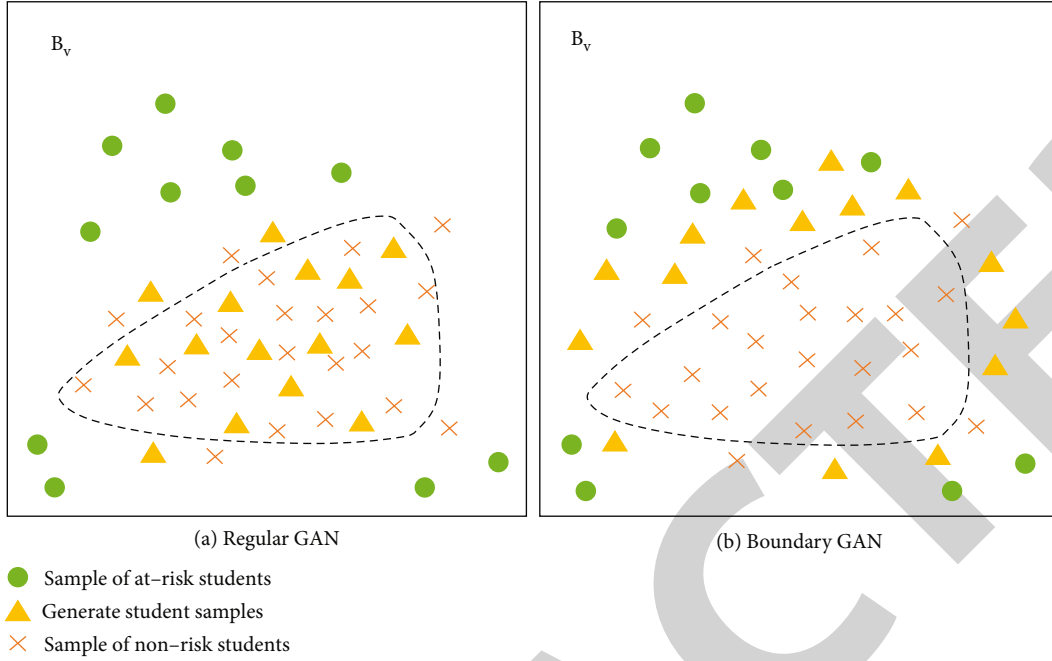


FIGURE 5: GAN and boundary GAN generator demo diagram.

Softmax function, the weight vector p_i is obtained:

$$p_i = \text{Softmax}(u^T m_i). \quad (15)$$

Then, calculate the weighted sum of the output memory module c_i according to p_i , and then, the output vector o of the model can be obtained:

$$o = \sum_i p_i c_i. \quad (16)$$

Finally, the two vectors o and q are added correspondingly, and the probability of the predicted answer is generated by the Softmax function:

$$a = \text{Softmax}(W(o + u)). \quad (17)$$

4. Result Analysis and Discussion

4.1. Experimental Data and Model Construction

4.1.1. Experimental Data. In this study, we collected two types of behavioral data from 505 anonymous graduate students to predict high-risk students in a course. One of the datasets records the online learning behavior of students during the course, and the other dataset collects web browsing behavior data from campus web logs, from which the behavior patterns of students accessing the Internet can be explored. Properly combining these two datasets will yield insights into student learning behavior patterns and factors associated with academic performance. However, there are two difficulties in the reasonable fusion and utilization of the two types of datasets:

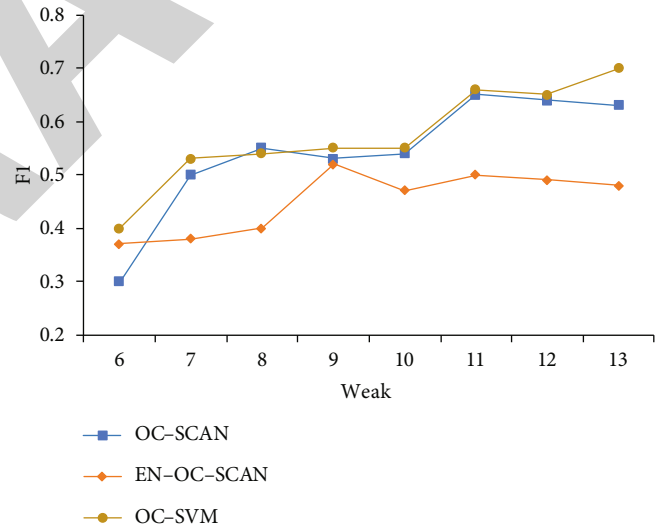


FIGURE 6: Comparison of early prediction performance of models.

- (1) The features that are valid in one class may not be the same in another class. At the same time, the dimension of the features is usually limited to a small size. These two defects limit the sequence input of the deep model
- (2) The two-part behavior sequences describe students' online behaviors from different granularities, which means that it is inappropriate to perform convolution operations on them in the same vector space; at the same time, the sequential splicing strategy requires that the category vector and the behavior vector have the same dimensions, which may not be optimal in practice

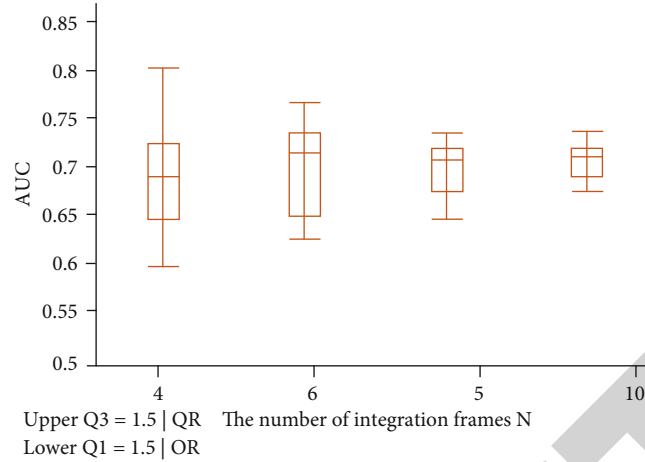


FIGURE 7: The effect of the integration framework N on the model AUC.

In order to solve the above problems, the SPDN framework proposed in this paper takes the specific learning behavior sequence of students as part of the original input and introduces the web browsing category sequence extracted from the campus log to describe the surfing habits. The two behavior sequences with different granularities are fused through the MGCNN module and input into the bidirectional LSTM together with the static information to predict the probability of students' future failure risk.

4.1.2. Model Design. We will mainly elaborate on the specific design of the proposed deep network-based sequence prediction model framework SPDN. The overall architecture of the framework is shown in Figure 3, which can be roughly divided into four parts. First, we will formulate the concepts and questions involved in our research. Then, we will introduce the process of constructing and embedding the complete input sequence in the input representation module. After that, we will discuss the specific content of multisource fusion CNN, MFCNN, which can automatically capture important online behavioral features of graduate students. Finally, we will introduce the process of combining static information with the student's online behavioral representation and feeding it into a bi-LSTM model for prediction.

4.2. Experimental Results and Analysis. To further evaluate the performance of the model for early warning of students' academic studies, we compared the AUC performance of the model when accumulating behavior sequences of different weeks as input, as shown in Figure 4. The performance of both SPDN and baseline models gradually improves as behavior sequences accumulate. Figure 4 only shows the performance line of random forest; other benchmark models have similar trends. It can be clearly seen that deep learning models always have higher AUC than general machine learning models. Furthermore, SPDN is able to reach prediction performance close to the final performance within the 7th week of the semester, while the deep model BLSTM_MA needs 11 weeks of student data to achieve the same performance as SPDN, and the appropriate weekly user behavior representation vector is generated. This facilitates the use

of SPDN for early prediction and allows sufficient time for teachers to intervene early.

Boundary GAN contains two components like regular GAN, generator, and discriminator. Figure 5 illustrates the difference between the generators of conventional GAN and boundary GAN, where the interior of the dotted line represents high-density regions of nonrisk students. The generator of conventional GAN generates samples that are close to nonrisk students, and the discriminator is used to distinguish close real samples from generated samples, while the generator of boundary GAN is designed to generate complementary samples of low-density regions of nonrisk student samples in the visible sample space, and the discriminator is used to distinguish between real ordinary students and complementary samples.

In order to evaluate the performance of the early warning of the boundary GAN model, the sequence of student feature vectors accumulated in different weeks 1 is used as input in turn, the student representation vector h_E at the corresponding time is learned, and the discriminator of the boundary GAN is used to calculate the probability of being a risk student. Figure 6 shows the trend of F1 scores of the models when OC-SCAN, optimized ensemble framework, and baseline OC-SVM use the sequence of student behaviors from the first 6 to 13 weeks, respectively, to give early warning to students.

In the optimization ensemble framework, in order to evaluate the impact of the number N of autoencoders on the performance, the size of N is set to 4, 6, 8, and 10, respectively, and the AUC indicators of repeated 10 experiments are shown in Box 7, respectively.

As can be seen from Figure 7, the more the number of N in the integrated framework, the better the overall prediction performance of the model. At the same time, when $N = 10$, the AUC of the model's multiple prediction results is more concentrated, indicating that the model is more stable. Therefore, it can be proved that the proposed ensemble framework helps to reduce the variance of the final prediction results and improve the overall prediction performance.

Since we believed that using the full long-term series as input would provide the model with the greatest amount



FIGURE 8: The corresponding relationship between the input and output weights of the IMNet model.

of information for accurate interpretation, we evaluated the interpretation predicted using the 13-week series. The results are shown in Figure 8. The top subgraph draws the student's various online learning behavior sequences during the semester, and the middle subgraph draws the student's behavior sequence for browsing various web pages. The ordinate is at every 6. The amount of time the behavior cumulatively occurred in the hourly time block. The subplot at the bottom plots the attention weights, and the ordinate is the weight. The abscissa of the three-part subgraph is the one-to-one corresponding timestamp.

Overall, we can intuitively observe that the size of the attention weight is highly correlated with the two categories of historical behaviors, and the more prominent and denser the behavior, the higher the assigned weight. At the same time, it can be found that IMNet also pays attention to the previous behavior sequences and assigns higher weights without losing important information.

5. Conclusion

Postgraduate education is the fastest and most effective way to cultivate our country's technological innovation and talent competitiveness. How to improve the quality of postgraduate education is an eternal theme. The internal quality assurance system must first optimize the tutor team to highlight the professional level, establish a diversified tutor evaluation accountability mechanism, and strictly promote the effective implementation of the tutor accountability mechanism; secondly, optimize the curriculum setting and content, highlight the characteristics of curriculum application, and adopt more flexible and diverse. It integrates theory and practice teaching, standardizes paper review and refines paper evaluation standards, improves student participation channels and feedback channels, creates an atmo-

sphere of excellent quality culture, and establishes a quality monitoring information platform. This paper uses multi-information fusion technology to model student behavior of Chinese postgraduates using multisource data and proposes a serialized prediction framework based on a deep network. Combined with the static characteristics of students, the long-term and short-term memory network is used to model the overall online behavior of students, and finally, experiments are carried out on the real university course dataset. The experimental results show that the performance of the algorithm proposed in this topic is better than the baseline comparison algorithm.

Data Availability

The figures 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.

Acknowledgments

The authors would like to show sincere thanks to those technicians who have contributed to this research. This work was supported by the National Social Science Fund of China, "Innovative Research on the mode and path of supply chain financing of small and micro enterprises under blockchain technology" (21BJL084).

References

- [1] K. B. Weiss, "Designing graduate medical education in the context of a value-based payment ecosystem," *The Joint*

- Commission Journal on Quality and Patient Safety*, vol. 47, no. 9, pp. 541-542, 2021.
- [2] L. Crawford, N. Cofie, L. Mcewen, D. Dagnone, and S. W. Taylor, "Perceptions and barriers to competency-based education in Canadian postgraduate medical education," *Journal of Evaluation in Clinical Practice*, vol. 26, no. 4, pp. 1124-1131, 2020.
- [3] I. Ancho, "Graduate education during COVID-19 pandemic: inputs to policy formulation in the new normal," *University of San Jose-Recoletos*, vol. 8, no. 2, pp. 87-105, 2020.
- [4] A. McGill, "A second-class degree or a real degree?," *Graduate College Based Higher Education sport students' perceptions of their HE experience*, vol. 18, no. 12, pp. 77-85, 2020.
- [5] T. I. Chowdhury, M. R. Hoque, P. Wanke, M. Z. Raihan, and M. A. K. Azad, "Antecedents of perceived service quality of online education during a pandemic: configuration analysis based on fuzzy-set qualitative comparative analysis," *Evaluation Review*, vol. 46, no. 3, pp. 235-265, 2022.
- [6] T. M. McGuinness, M. R. Shirey, C. Cleveland, J. Richardson, R. Campbell, and D. C. Harper, "An innovative approach for graduate education for psychiatric nurse practitioners," *Journal of Professional Nursing*, vol. 36, no. 6, pp. 526-530, 2020.
- [7] H. Kuzu, "A study on the problems of graduate education in the process of change in higher education," *Journal of International Social Research*, vol. 13, no. 70, pp. 753-768, 2020.
- [8] M. Dolmaz and G. O. İlhan, "Trends of graduate theses with the subject of education and training conducted on creativity," *World Journal of Education*, vol. 10, no. 5, p. 61, 2020.
- [9] R. Madleňák, S. P. D'Alessandro, A. Marengo, J. Pange, and G. I. Neszmeľyi, "Building on strategic eLearning initiatives of hybrid graduate education a case study approach: MHEI-ME Erasmus+ project," *Sustainability*, vol. 13, no. 14, p. 7675, 2021.
- [10] P. J. Schenarts and J. Bourne, "Invited response to the inadvertent personal liability of graduate medical education (ASU-21-0920-letter to the editor)," *The American Surgeon*, vol. 87, no. 11, p. 1850, 2021.
- [11] Y. Ma, B. Yuan, and K. Jin, "Study on monitoring and analysis of rock dynamic disaster based on multi-parameter coupling," *IOP Conference Series: Earth and Environmental Science*, vol. 525, no. 1, p. 12026 (10pp), 2020.
- [12] I. Kholod, "The diagnosis of teachers' postgraduate education quality," *Training*, vol. 1, no. 23, pp. 139-147, 2021.
- [13] K. Dimino, K. Louie, J. Banks, and E. Mahon, "Exploring the impact of a dedicated education unit on new graduate nurses' transition to practice," *Journal for Nurses in Professional Development*, vol. 36, no. 3, pp. 121-128, 2020.
- [14] I. Burnell, J. Roffey-Barentsen, and A. McMahon, "Widening graduate employment opportunities for students on education studies degrees: a case study at a school of education in one London university," *Widening Participation and Lifelong Learning*, vol. 23, no. 1, pp. 178-190, 2021.
- [15] K. Clare, M. Jennifer, P. Saifon, N. Schvaneveldt, B. Patterson, and J. W. Guo, "Game-based quality improvement teaching: using taters in nursing education," *Journal of Nursing Education*, vol. 60, no. 10, pp. 590-593, 2021.
- [16] O. L. Zavalina and M. Burke, "Assessing skill building in meta-data instruction: quality evaluation of dublin core metadata records created by graduate students," *Journal of Education for Library and Information Science*, vol. 62, no. 23, pp. 47-52, 2021.
- [17] R. Grayna and M. Renata, "The value of postgraduate students opinions in the quality management of academic E-learning," *Foundations of Management*, vol. 13, no. 15, pp. 188-195, 2021.
- [18] M. Huang, "Novel intelligent spatiotemporal grid earthquake early-warning model," *Remote Sensing*, vol. 13, no. 18, pp. 225-231, 2021.
- [19] Z. K. Hou, H. L. Cheng, S. W. Sun, J. Chen, D. Q. Qi, and Z. B. Liu, "Crack propagation and hydraulic fracturing in different lithologies," *Applied Geophysics*, vol. 16, no. 2, pp. 243-251, 2019.
- [20] D. Li, Y. Deng, and H. C. Kang, "Multisource basic probability assignment fusion based on information quality," *International Journal of Intelligent Systems*, vol. 36, no. 4, pp. 1851-1875, 2021.
- [21] H. Cheng, P. Ma, G. Dong, S. Zhang, J. Wei, and Q. Qin, "Characteristics of carboniferous volcanic reservoirs in Beisantai Oilfield, Junggar Basin," *Junggar Basin Mathematical Problems in Engineering*, vol. 2022, pp. 1-10, 2022.
- [22] B. Li, E. Wang, Z. Shang et al., "Optimize the early warning time of coal and gas outburst by multi-source information fusion method during the tunneling process," *Process Safety and Environmental Protection*, vol. 149, no. 15, pp. 839-849, 2021.