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Design and Implementation of the Employment Management Decision Support System based on Machine Learning

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Abstract: To address the challenges of current college student employment management, this study designed and implemented a machine learning-based decision support system for college student employment management. The system collects and analyzes multidimensional data, uses machine learning algorithms for prediction and matching, provides personalized employment guidance for students, and provides decision support for universities and enterprises. The research results indicate that the system can effectively improve the efficiency and accuracy of employment guidance, promote school-enterprise cooperation, and achieve a win-win situation for all parties.

Keywords: Machine learning; Employment of college students; Decision support system; Data analysis

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1. Introduction

In recent years, with the rapid development of higher education, the employment problem of college students has become increasingly prominent and become the focus of attention from all walks of life. Facing the increasingly fierce competition in the employment market, the employment management of colleges and universities is facing unprecedented challenges. The traditional employment management mode has been difficult to meet the current needs, information asymmetry, lack of personalized employment guidance, and other problems that need to be solved. In this context, the state has issued a series of policies to encourage universities to innovate employment service models and improve the level of employment guidance. Therefore, it is particularly important to construct a decision support system for college students based on machine learning.

2. System background and requirements analysis

2.1. Background introduction

Currently, the employment situation of college students is becoming increasingly severe, mainly due to the continuous rise in the number of graduates, the slowdown of the economic growth rate, and the long-term impact

of the pandemic. The employment management of colleges and universities faces multiple challenges, and one of the significant problems is information asymmetry. Students are often unable to obtain accurate employment information in time, and enterprises also find it difficult to locate suitable talent. Additionally, employment guidance services are usually not personalized, and most colleges and universities still adopt the "one-size fits all" guidance model, ignoring the diversified needs and personality development of students [1]. The existence of these problems makes the efficiency of employment management low, which affects the career development of students and the recruitment effect of enterprises.

2.2. Demand analysis

In terms of colleges and universities, the demand focuses on how to efficiently manage massive employment information, quickly match students and positions, and improve the quality and efficiency of employment services. In terms of students, they are eager to obtain more personalized and accurate employment guidance and consulting services and hope that the employment system can provide customized suggestions according to their interests, abilities, and career planning. In terms of enterprises, the demand is more reflected in how to quickly find high-quality talents that meet the job requirements, and how to deepen cooperation with universities and intervene in the talent training process in advance, to ensure that the recruited talents can quickly adapt to the job demand [2].

2.3. Technical feasibility discussion

Machine learning technology has shown great potential in processing large amounts of data, mining potential patterns, and conducting predictive analysis, providing a new perspective for solving problems in employment management. Through data mining, the system can analyze historical employment data, and understand employment trends and the key factors affecting employment success [3]. In terms of prediction model construction, machine learning can predict students' employment tendencies and success rates through the analysis of students' abilities, interests, and enterprise job needs, to provide more accurate matching services for enterprises and students.

2.4. System goal setting

The main goal of the system design is to improve the efficiency of employment guidance and to optimize the processing and matching process of employment information by introducing machine learning algorithms. In terms of optimizing resource allocation, the system aims to realize the intelligent allocation of employment resources, reduce the waste of resources, and improve the speed and accuracy of the matching between positions and talents. Moreover, the system is also committed to promoting university-enterprise cooperation. Through accurate matching and data analysis, it provides enterprises with comprehensive talent information and feedback on industry needs for universities, to promote the innovation and improvement of talent training mode and achieve a win-win situation [4].

3. System design and implementation

3.1. System architecture design

The rationality and efficiency of system architecture design are directly related to the performance and stability of the entire system. In response to the specific needs of the college student employment management system, the system architecture design has been carefully planned into four core levels to ensure smooth data flow and efficient processing.

The bottom layer is the data collection layer, whose main task is to widely collect various types of data

related to college students' employment [5]. The sources of data are diverse, including but not limited to student employment intention surveys, corporate recruitment information, and industry trends. To achieve automated data collection and real-time updates, the system adopts advanced web crawling technology and Application Programming Interface (API), ensuring the comprehensiveness and timeliness of the data.

Next is the data processing layer, whose main responsibility is to clean, transform, and load the collected data. By utilizing Extract, Transform, Load (ETL) technology, the system can efficiently process massive amounts of data, remove redundant information, and ensure data quality and consistency. This step provides a solid foundation for subsequent data analysis.

The model analysis layer is the intelligent core of the entire system. At this level, the system utilizes various machine learning algorithms such as random forest and support vector machines to conduct in-depth analysis and mining of the processed data. By identifying key information such as employment trends and student potential, the system can provide students with more accurate employment guidance and advice.

The top layer is the decision support layer, which directly faces users and provides personalized decision support services. Based on the output results of the model analysis layer, the decision support layer uses technologies such as decision trees and neural networks to tailor employment guidance plans for students, helping them better plan their careers [6].

Simultaneously, this layer also provides valuable resource allocation and strategic decision-making basis for universities, helping them optimize employment management processes and improve the quality of employment guidance services. With the careful design and collaborative work of these four levels, the system architecture design of the college student employment management system can comprehensively achieve smooth data flow and efficient processing. This not only improves the performance and stability of the system but also provides users with a higher quality and personalized service experience [7].

3.2. Selection of key technologies and algorithms

In the field of machine learning, selecting suitable algorithms for the decision support system of college student employment management is the core to ensure excellent system performance and accurate decision-making. In the classification task, the prediction of student employment success rate adopts the Support Vector Machine (SVM) algorithm. As a supervised learning model, SVM's main advantage lies in its excellent performance in handling high-dimensional data, largely due to its core principle of maximizing classification margins. In short, SVM distinguishes data points of different categories by finding an optimal hyperplane, while ensuring that the distance between the hyperplane and the nearest data point (i.e. support vector) of any category is maximized [8]. This strategy not only enhances the model's generalization ability, that is, its adaptability to unknown data, but also enables SVM to effectively classify in complex multidimensional spaces.

In the field of cluster analysis, the K-means algorithm has become the preferred method for effectively grouping students to implement personalized employment services. The K-means algorithm is an unsupervised learning method that aims to partition a dataset into a predefined number of K clusters. The algorithm starts with K randomly initialized centroids, then assigns each data point to the cluster where its nearest centroid is located, and updates the centroid position based on these assignments. This process continues to iterate until the centroid position no longer changes or changes minimally. The reason why the K-means algorithm is favored is because its algorithm logic is concise, implementation is convenient, and it can still maintain high efficiency and good clustering effect when processing large-scale datasets [9].

For the recommendation system, the decision support platform adopts a hybrid strategy of content-based recommendation algorithm and collaborative filtering algorithm. Content-based recommendation focuses on

analyzing the attributes of items (such as positions) and user preferences and making recommendations by comparing the similarity between these attributes and preferences [10]. The advantage of this method is that it can directly utilize the attribute information of items and the user's preference history to recommend options that meet their personalized needs. The collaborative filtering algorithm analyzes user historical behavior data to find other users with similar behavior patterns to the target user and then recommends based on the behavior and preferences of these similar users. The advantage of this method is that it can discover users' implicit preferences and recommend unexpected items that meet their interests [11].

Combining these two algorithms can ensure the personalization and accuracy of recommendations, while also utilizing the rich information in the content to improve the intuitiveness and interpretability of recommendations. During the implementation of the system, algorithm parameters are continuously adjusted and optimized through repeated experimentation and continuous feedback loops, to achieve optimal system performance and decision support effectiveness [12]. The specific steps are shown in **Figure 1**.

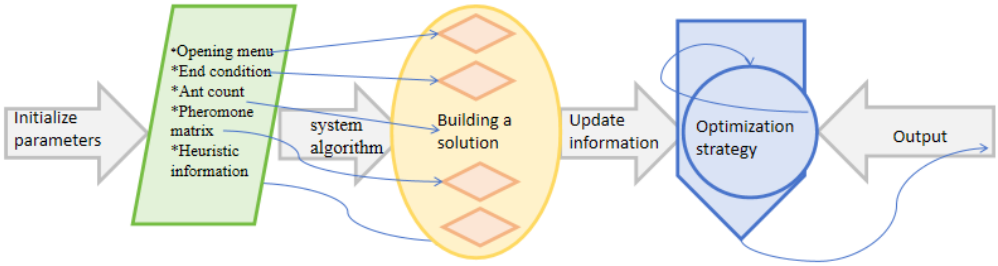

Figure 1. Ant colony optimization flowchart

3.3. Functional module development

3.3.1. Data collection and preprocessing module

The core task of this module is to automatically collect student information and job market data from diverse data sources. We use the BeautifulSoup library in Python for web page parsing and develop efficient web crawlers using the Scrapy framework to achieve extensive data collection. In the preprocessing stage, we use the Pandas library for data cleaning, which includes key steps such as removing duplicate data and filling in missing values to ensure data integrity and accuracy, laying a solid foundation for subsequent analysis [13].

3.3.2. Data analysis and prediction module

This module uses the Scikit learn library to build a machine learning model and uses algorithms such as random forests to accurately predict employment trends. We use cross-validation techniques to select the optimal parameter combination to maximize the predictive accuracy of the model [14]. This not only enhances the depth of analysis but also provides strong data support for decision-making.

3.3.3. Decision support module

Based on the analysis results of machine learning models, we use decision tree algorithms to tailor employment guidance recommendations for students, helping them better plan their careers. Concurrently, these analysis results also provide data-driven decision support for university administrators, helping them formulate more scientific and reasonable education policies [15].

3.3.4. User interaction interface design

We use an advanced web technology stack for interface development, with the React framework used for the front

end to create interactive and dynamically updated user interfaces, and the Node.js and Express framework used for the back end to handle complex business logic and data requests [16]. This design ensures that users can enjoy a simple and intuitive operating experience.

3.4. System testing and optimization

In the process of system development and deployment, system testing and optimization are directly related to the final quality of the system and the actual user experience. The system testing phase carefully designed four major testing stages: functional testing, performance testing, stress testing, and user acceptance testing, aiming to comprehensively verify the stability of the system and user satisfaction. Functional testing is the cornerstone of ensuring the normal operation of various modules in the system. The testing team rigorously verifies the accuracy of data collection, the rationality of analysis and prediction, and other key functions by constructing a series of test cases, ensuring that the system can run stably as expected [17].

Performance testing focuses on the performance of the system under different loads. Using professional performance testing tools such as Apache JMeter, the testing team simulated various load scenarios to evaluate the system's response time and resource utilization. This step is crucial to ensure that the system can maintain high efficiency even in high concurrency situations, providing strong support for the stable operation of the system. Stress testing further challenges the system's ultimate performance. By continuously increasing the system load, the testing team observed the stability and load-bearing capacity of the system, providing valuable reference data for subsequent optimization. User acceptance testing is the bridge that connects system design with user requirements.

The testing team collected real feedback from the target user group and made detailed adjustments and optimizations to key dimensions such as interface friendliness and functional practicality. Based on this feedback, the system has undergone multiple iterations, continuously optimizing the data processing flow, adjusting model parameters, and improving the user interface to provide a better user experience. After these rigorous and meticulous testing and optimization steps, the system gradually moves towards perfection, more accurately meeting the practical needs of college students' employment management and providing strong support for users' career development [18].

4. System development direction

4.1. Technological innovation and development

It is expected that future technological innovation will revolve around cutting-edge technologies such as deep learning and reinforcement learning, which will bring deeper changes to the decision support system for college student employment management. Unlike existing systems that rely on traditional machine learning algorithms, future systems will adopt deep neural networks such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) to capture more complex data patterns and relationships.

For example, when processing natural language data such as student resumes or business job descriptions, RNNs and Long Short-Term Memory Networks (LSTM) can better understand semantics and context, thereby improving matching accuracy [19]. Furthermore, reinforcement learning algorithms can be applied to dynamically adjust employment guidance strategies. The system can self-optimize based on student feedback and enterprise recruitment results, continuously improving the accuracy of recommendations and employment success rates.

4.2. System expansion and upgrade

Future system upgrades will focus on introducing more diverse data sources and more intelligent analysis tools

to achieve comprehensive employment services. On the one hand, the system will integrate unstructured data sources such as social media, industry forums, and professional websites to obtain the latest employment trends and industry demand information, providing students with more forward-looking employment guidance. On the other hand, the system will introduce knowledge graph-based technology to construct student ability models and enterprise job models, achieving more accurate semantic matching. The upgraded system will also include Virtual Reality (VR) and Augmented Reality (AR) technologies, allowing students to undergo skill training and interview exercises in a simulated workplace environment, enhancing their job competitiveness.

4.3. School enterprise cooperation and talent cultivation

The future employment management system will further deepen the cooperation between schools and enterprises, by building a cooperation platform, enabling enterprises to directly participate in the talent training plans of universities. Enterprises can not only publish job information through the system but also provide customized internship positions and project topics to guide students in completing academic projects closely related to their actual work. Universities can dynamically adjust course content and teaching methods based on feedback from enterprises and market data to cultivate more competitive talents in the market. The system will also establish an alumni network tracking mechanism to continuously collect career development data of graduates, providing a basis for continuous improvement in school-enterprise cooperation, forming a virtuous cycle, and promoting close integration between education and the job market.

5. Conclusion

In summary, the machine learning-based decision support system for college student employment management proposed in this study provides a new perspective and method for employment management at the theoretical level and effectively improves the efficiency and accuracy of employment guidance at the practical level. This system not only helps students obtain more personalized employment guidance but also promotes deep cooperation between universities and enterprises. In the future, with the continuous advancement of technology and the deepening of applications, this system is expected to play an important role in a wider range of fields, providing stronger support for college students' employment management.

Disclosure statement

The author declares no conflict of interest.

References

[1] Li H, Zhang C, 2023, Research on the Impact of Individual Effort and Family Background on the Employment Quality of College Students Based on Machine Learning. Chinese Adult Education, 2023(21): 25–29.

[2] Li J, Zheng Y, Tang Y, et al., 2022, Machine Learning Based Analysis of Resume Data for College Students. Technological Innovation and Application, 12(2): 83–86. https://doi.org/10.19981/j.CN23-1581/G3.2022.02.021

[3] Guan Z, Fang L, 2022, A Brief Analysis of Predicting and Coping with the Graduation Destination of College Students under Machine Learning SVM Algorithm: Based on the Framework of Human Capital and Social Capital. Special Economic Zone, 2022(8): 121–126.

[4] Sun Y, Pan K, Sun Z, et al., 2019, Ideas and methods for predicting the Graduation Destinations of College Students: An Attempt based on Machine Learning Algorithms. Education Academic Monthly, 2019(1): 25–35.

[5] Lin L, 2021, Design and Implementation of a College Student Employment System Platform Based on Computer Artificial Intelligence. Computer Knowledge and Technology, 17(2): 158–160.

[6] Ma D, 2021, Strategies for Enhancing the Employment Competitiveness of College Students under the Background of Artificial Intelligence. Comparative Study on Cultural Innovation, 5(6): 20–22.

[7] Zhao L, Chen H, 2019, Application Analysis of Job Skills Extraction in Recruitment Information based on Machine Learning. Computer Knowledge and Technology, 15(33): 211–212.

[8] Cui X, 2023, Design and Implementation of a Smart Employment Recommendation System Based on Big Data Analysis and Artificial Intelligence. Journal of Hebei Software Vocational and Technical College, 25(2): 15–19.

[9] Yin H, Li H, 2022, Development and Practice of an Intelligent Matching System for Precise Employment Supply and Demand of Vocational College Graduates Based on Big Data. Computer Knowledge and Technology, 18(29): 63–66.

[10] Zhao L, Li L, 2019, Analysis of Student Employment Skills Based on Machine Learning. Computer Knowledge and Technology, 15(34): 190–191.

[11] Lai S, 2020, A Machine Learning based Job Recommendation and Salary Prediction System, thesis, South China Agricultural University.

[12] Huang X, Liu D, 2018, Recommendation and Evaluation Methods based on Machine Learning. Software Engineering, 21(5): 8–11.

[13] Lu L, Li Y, Wang C, 2023, The Impact of Artificial Intelligence on Skills and Future Employment in the Media Industry: A Method Based on Machine Learning and Network Analysis. News University, 201(1): 101–117.

[14] Liu H, 2021, Research on Employment Quality Evaluation Method Based on Artificial Intelligence and Data Information Analysis. Electronic Design Engineering, 29(24): 145–149.

[15] Ma J, Wang M, Dai Y, et al., 2021, Computer based Employment Assistance Applications based on NLP Technology. Communication World, 28(3): 221–222.

[16] Xiao Y, Li X, Liu W, 2024, Research on Strategies for Improving the Employment Competitiveness of College Students in the New Era. Education and Teaching Forum, 2024(27): 185–188.

[17] Tan Y, Wang C, 2023, Research on the Employment Destination Model of College Students based on Logistic Regression Classification Algorithm. Theoretical Research and Practice of Innovation and Entrepreneurship, 6(3): 6–12.

[18] Yang X, Liu Y, Zhang X, et al., 2023, Research on Predicting the Employment Ability of College Graduates Based on GA_XGBoost. Software, 44(2): 37–41.

[19] Fang D, Jie B, Zhan Y, et al., 2023, Research on the Influencing Factors of College Students' Career Choices based on Data Analysis. China Education Informatization, 29(11): 64–75.

[20] Gu Y, 2022, Prediction of Employment Destinations for College Students based on Machine Learning Algorithms. Microcomputer Applications, 38(2): 172–175.