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Design and Application of Intelligent Recommender Systems in Vocational Rehabilitation

Siran Yang*

Second Clinical Medical College, Yunnan University of Chinese Medicine, Kunming, China

*Corresponding author: 1705789165@qq.com

Abstract. With the rapid development of information technology, the application of intelligent recommender systems in various fields has become more and more extensive, and vocational rehabilitation, as a field focusing on personalized services, faces the challenge of how to effectively use big data and intelligent algorithms to enhance the rehabilitation effect. This paper discusses the design principles and key technologies of intelligent recommender system in vocational rehabilitation, combining data-driven recommendation algorithms with users' personalized needs to achieve accurate recommendation of vocational rehabilitation programs. Through the optimization of system architecture and functional implementation, the intelligent recommender system shows remarkable effects in practical application, effectively improving the decision-making efficiency and user satisfaction in the rehabilitation process. Finally, this paper gives an outlook on the future development of the intelligent recommendation system in the field of vocational rehabilitation, and proposes possible research directions and application expansion paths.

Keywords: vocational rehabilitation, intelligent recommender system, personalized recommendation, algorithm design, data-driven, system architecture.

1. Introduction

The importance of vocational rehabilitation is becoming more and more prominent with the continuous development of society and economy and the advancement of science and technology[1]. Vocational rehabilitation aims to help individuals who have lost part of their working capacity due to illness, disability or other reasons to recover their vocational ability and reintegrate into the workplace through systematic rehabilitation training and guidance[2]. However, traditional vocational rehabilitation methods often rely on manual experience and generic programs, making it difficult to meet the specific needs of different rehabilitated individuals. With the rapid development of big data, artificial intelligence and other technologies, intelligent recommender systems have brought new opportunities to the field of vocational rehabilitation.

As a technology based on data analysis and algorithmic optimization, the intelligent recommendation system can effectively tap into the personalized needs of users and provide accurate rehabilitation advice and career guidance[3]. This not only improves the efficiency of the rehabilitation process, but also greatly enhances the personalization and relevance of the rehabilitation effect. In recent years, intelligent recommender systems have been widely used in e-commerce, social media and other fields, demonstrating their powerful adaptability and application value[4]. However, in the special field of vocational rehabilitation, the application of intelligent recommender systems is still in the exploration stage.

The research focus of this paper is to explore how to effectively apply the intelligent recommender system in vocational rehabilitation to design a set of personalized rehabilitation programs for the different needs of rehabilitated individuals[5]. The article will introduce in detail the design principles of the system, the core algorithm and its effect in practical application, aiming to provide theoretical support and practical reference for the intelligent development of vocational rehabilitation[6].

2. Design Principles for Intelligent Recommender Systems in Vocational Rehabilitation

The core goal of vocational rehabilitation is to help individuals regain their ability to work, and the needs of each rehabilitated individual often vary widely depending on his or her health condition, occupational background, and personal interests[7]. Therefore, the intelligent recommendation system must be designed with full consideration of individualized needs, identifying users' specific needs and rehabilitation goals through accurate data analysis[8]. The system should be able to dynamically adjust the recommended content to ensure that each user receives the advice and resources that are most suitable for his or her rehabilitation process and maximize the rehabilitation effect. Formula for Personalized Recommendation Score:

$$S_{i,j} = \frac{\sum_{k=1}^{n} r_{i,k} \cdot r_{j,k}}{\sqrt{\sum_{k=1}^{n} r_{i,k}^2} \cdot \sqrt{\sum_{k=1}^{n} r_{j,k}^2}} \tag{1}$$

In vocational rehabilitation, every recommendation decision made by the system should be based on a large amount of data. The data should not only include the user's health records and vocational experience, but also cover real-time feedback and progress during the rehabilitation process[9]. Through deep data analysis and machine learning algorithms, the system can extract valuable information from the massive data to support personalized customization and dynamic adjustment of rehabilitation programs[10]. Data-driven decision support ensures the science and effectiveness of recommendations and avoids the subjectivity and limitations found in traditional rehabilitation programs. Formula for Updating the Weight in a Deep Learning Model:

$$W_{new} = W_{old} - \eta \cdot \frac{\partial L}{\partial W} \tag{2}$$

Intelligent recommendation systems in vocational rehabilitation should be designed to be simple and intuitive so that they can be easily used and understood by users. Individuals in rehabilitation may face barriers to use due to health issues or lack of experience with the technology, so the system interface should be simplified as much as possible and provide clear guidelines. In addition, the system should be accessible and support a wide range of devices and operating environments to ensure that users with different backgrounds and needs are able to use the system without barriers. Such a design can effectively increase user participation and thus improve the effectiveness of rehabilitation.

Privacy and security of user data are factors that must be prioritized when designing an intelligent recommendation system in vocational rehabilitation. The rehabilitation process involves a large amount of personal health information and vocational information, and the leakage of these data may have serious impacts on users. Therefore, the system should adopt strict encryption measures and access control mechanisms to ensure the security of user data during transmission, storage and processing. At the same time, the system should follow relevant laws and regulations and provide a transparent data usage policy so that users can use it with confidence.

3. Key Technologies for Intelligent Recommender Systems in Vocational Rehabilitation

In vocational rehabilitation, the efficient operation of the intelligent recommendation system relies on the integration and optimization of several key technologies. First, data collection and processing technology is the foundation of the system, which ensures that the recommendation algorithm can obtain high-quality and comprehensive data support. Second, the design and optimization of the recommendation algorithm directly determines the recommendation accuracy and effect of the system, which must be continuously adjusted and improved according to the needs and characteristics of the recovered individuals. Finally, the system architecture and implementation is the core of transforming

data and algorithms into practical applications, ensuring the stability, scalability and user experience of the system through reasonable architectural design and technical implementation. Together, these key technologies constitute the technical pillars of the intelligent recommendation system in vocational rehabilitation, making personalized and accurate vocational rehabilitation possible.

3.1. Data collection and processing Data sources and types

Health data is one of the important foundations of intelligent recommendation systems in vocational rehabilitation. It includes the user's medical history information, diagnostic reports, treatment records, rehabilitation training data and so on. These data reflect the user's physical condition and rehabilitation progress, and are key references for developing personalized rehabilitation programs. During the data collection process, the system needs to dock with multiple data sources, such as hospitals, rehabilitation centers, wearable devices, etc., to ensure the completeness and accuracy of the health data. Meanwhile, real-time updating of health data is crucial for dynamic adjustment of rehabilitation programs, so the system must have efficient data synchronization and processing capabilities.

The user's occupational background data is an important basis for the intelligent recommender system to provide vocational reconstruction suggestions for rehabilitated individuals. Such data include information on the user's vocational experience, skill level, working environment, vocational qualifications, and so on. By collecting such data, the system can understand the user's vocational ability and potential development direction after rehabilitation, so as to provide more suitable vocational rehabilitation suggestions for the user. For example, for a worker with years of experience in machine operation, the system can recommend relevant skills training courses or positions. In addition, the vocational background data can also help the system assess the user's potential for career change and provide support for career transition. Heatmap of User-Item Ratings showed in Figure 1 :

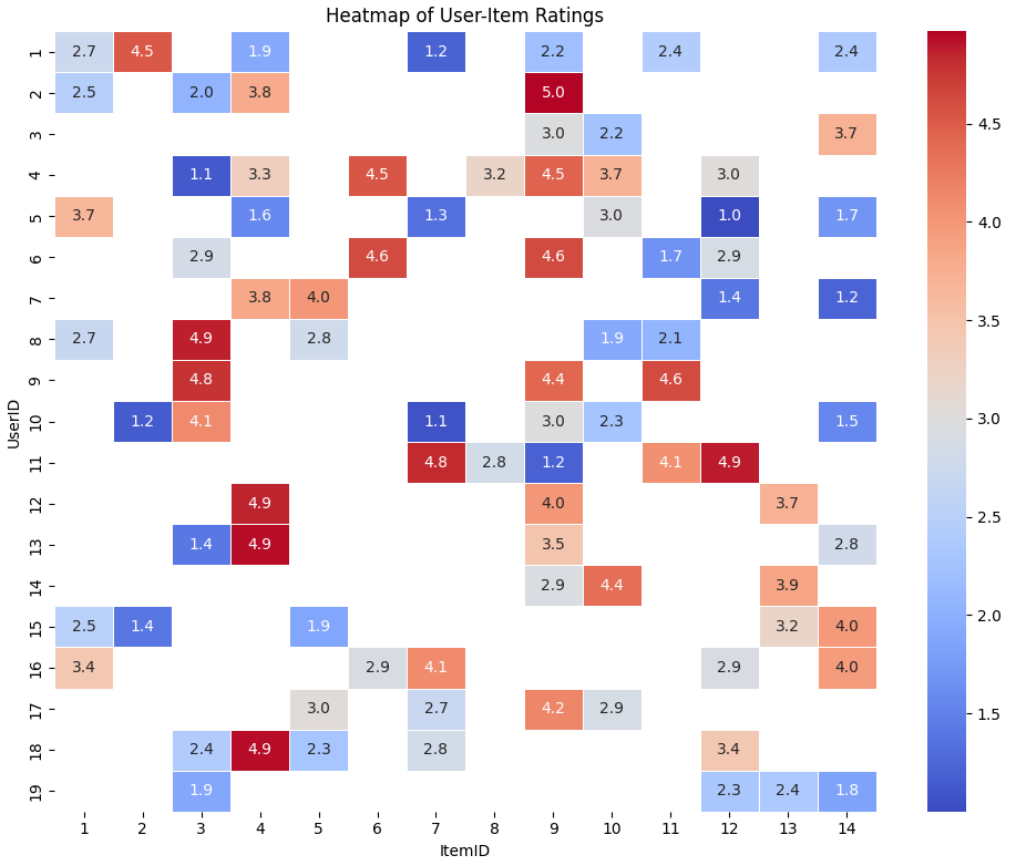

Figure 1 Heatmap of User-Item Ratings

Vocational rehabilitation involves not only physical recovery but also psychological and behavioral adjustment. Therefore, the collection of psychological and behavioral data from users is essential for the system to provide a comprehensive rehabilitation program. These data can be obtained through questionnaires, psychological assessment tools, and records of users' behavior during the rehabilitation process. For example, the system can track information such as the user's rehabilitation participation, emotional state, and stress level to identify psychological barriers in the rehabilitation process and provide appropriate psychological support and intervention recommendations. The collection of these data helps the system to fully understand the user's rehabilitation needs and improve the overall effectiveness of the recommended program.

Social and environmental data include information on the user's family support, frequency of social interactions, and living environment. This type of data has an important impact on vocational rehabilitation; for example, good family support and a positive social environment can help a user's rehabilitation progress, while a poor living environment may be a hindrance to rehabilitation. By collecting this data, the system can more accurately assess the user's rehabilitation environment and provide appropriate recommendations and interventions. In addition, social and environmental data can help the system identify potential social resources, such as community rehabilitation services and vocational guidance organizations, to further support the user's vocational rehabilitation process.

3.2. Design and Optimization of Recommendation Algorithms Introduction to Commonly Used Recommendation Algorithms

Collaborative filtering algorithm is one of the most commonly used algorithms in intelligent recommender systems, which is widely used in the recommendation scenario of vocational rehabilitation. It discovers commonalities between similar users by analyzing the behaviors and preferences of different users and makes recommendations based on these commonalities. Collaborative filtering algorithms are categorized into two types: user-based and item-based. User-based collaborative filtering algorithms recommend items to the target user based on items preferred by users with similar behaviors to the target user, while item-based collaborative filtering algorithms recommend items similar to items previously preferred by the target user. The advantage of collaborative filtering algorithms is that they do not rely on the content characteristics of the items, but are predicted by the user's behavioral data, which is suitable for recommending based on the rehabilitation paths of similar individuals in vocational rehabilitation,showed in Figure 2 :

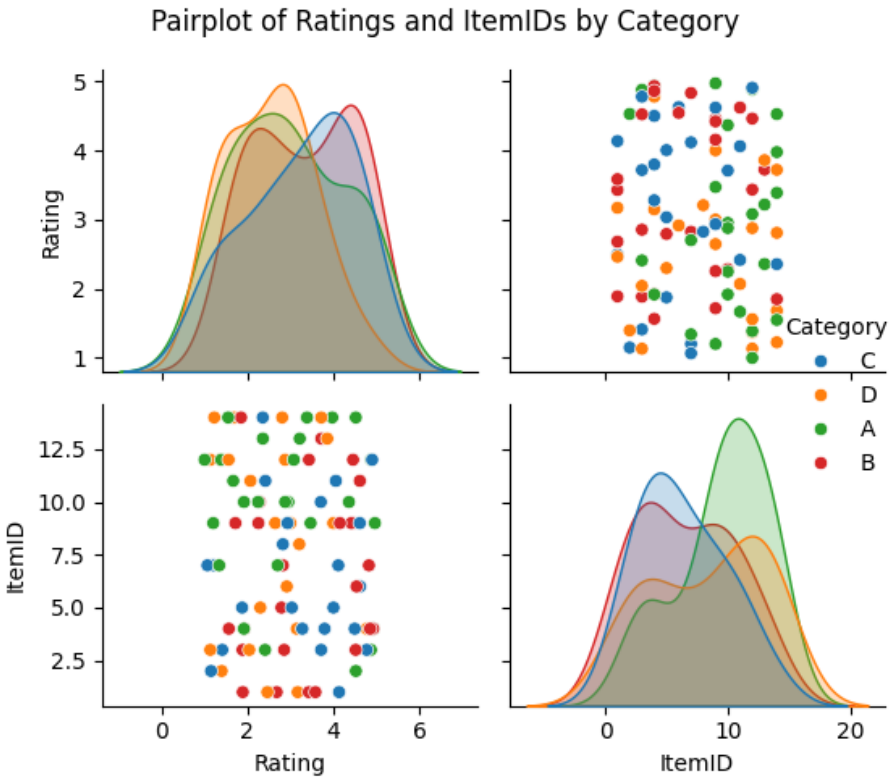

Figure 2 Pairplot of Ratings and ItemIDs by Category

Content recommendation algorithms make recommendations by analyzing the attributes or content features of the program itself. In a vocational rehabilitation scenario, the system can recommend other programs that are similar to the user's existing rehabilitation program based on the characteristics of the rehabilitation training program, such as the type of training, intensity, and skills required. This type of algorithm is especially suitable for situations where the user's preference is relatively clear, for example, when the user shows significant interest in a certain type of vocational training or rehabilitation program, the system can recommend other programs with similar characteristics. The advantage of content recommendation algorithms is that they do not rely on other users' data, and can provide high-quality recommendations despite the lack of a large amount of user behavioral data, which is especially suitable for the recommendation of new users or new programs.

A hybrid recommendation algorithm is an approach that combines collaborative filtering and content recommendation algorithms to overcome the limitations of a single algorithm and improve the accuracy and diversity of recommendations. In vocational rehabilitation, the hybrid recommendation algorithm can consider both the user's behavioral data and the program's content characteristics to generate more personalized and accurate recommendations. For example, the system can first filter out the programs that meet the user's current rehabilitation needs through the content recommendation algorithm, then analyze the feedback of other users on these programs through the collaborative filtering algorithm, and ultimately recommend the most suitable programs. This approach effectively avoids the cold-start problem or lack of recommendation diversity that a single algorithm may bring.

With the rapid development of deep learning technology, recommendation algorithms based on deep learning have begun to emerge in the field of vocational rehabilitation. By building complex neural network models, these algorithms can automatically learn and capture the deep relationship between user behavior and program features to generate more accurate recommendations. Deep learning recommendation algorithms are capable of handling high-dimensional, non-linear data and are suitable for complex vocational rehabilitation scenarios, such as recommendation tasks that simultaneously consider multiple dimensions such as a user's health status, occupational background, and psychological characteristics. Although such algorithms usually require larger computational

resources and data support, they show significant advantages in improving recommendation results, especially when dealing with multimodal data and personalized requirements.

3.3. System Architecture and RealizationOverall System Architecture Design

The overall architecture design of an intelligent recommendation system in vocational rehabilitation needs to take into account multiple aspects such as data processing, recommendation algorithm execution, user interaction and security management. The system usually adopts a layered architecture, including data layer, algorithm layer, application layer and user layer. This layered design helps the independent development and optimization of each module, and can effectively improve the scalability and maintainability of the system. In this architecture, the data layer is responsible for the collection, storage and pre-processing of multi-source data, the algorithm layer carries out data analysis and recommendation decision-making, the application layer realizes specific business logic and service interfaces, and the user layer is the interface for users to interact with the system.

The data layer is the foundation of an intelligent recommendation system, which is responsible for obtaining and integrating data from multiple data sources and ensuring efficient storage and fast access to the data. In vocational rehabilitation systems, the data layer needs to handle multiple types of data, including health data, vocational background data, psychological and behavioral data, social and environmental data, etc. To support the processing of these data, the system usually adopts distributed databases and big data processing frameworks, such as Hadoop or Spark. the data layer should also have data cleaning and transformation functions to ensure the quality of data input into the recommendation algorithm. In addition, the data layer needs to provide real-time data stream processing capabilities to support the dynamic recommendation function of the system.

The algorithm layer is the core of the system, which analyzes and processes the data provided by the data layer to generate personalized recommendation results. The algorithm layer includes a variety of recommendation algorithm modules, such as collaborative filtering algorithms, content recommendation algorithms, hybrid recommendation algorithms and deep learning algorithm modules. In order to improve the efficiency and accuracy of the algorithm, the system usually adopts mechanisms such as model training, parameter tuning and online learning. The algorithm layer should also have efficient algorithm selection and combination functions, and be able to select the most appropriate combination of algorithms according to the different needs and scenarios of users. In addition, the algorithm layer needs to have good scalability to support the integration and optimization of new algorithms in the future.

The application layer is responsible for transforming the results of recommendation algorithms into services and functions visible to users. It includes modules such as system interface, business logic, user management and security control. In vocational rehabilitation, the application layer needs to provide a variety of functional interfaces, such as recommendation result display, user feedback collection, and rehabilitation process tracking. In addition, the application layer should have strong security management functions to protect user data privacy and system security. The user layer is the direct interactive interface between the system and the user, which usually includes Web and mobile applications. The user interface design should be simple and intuitive to ensure that users can easily access and use the system functions and provide a personalized experience.

4. Analysis of the Effectiveness of the Application of Intelligent Recommender System in Vocational Rehabilitation

The application of intelligent recommendation system in vocational rehabilitation significantly improves the efficiency of personalized rehabilitation program development. By analyzing the user's health data, occupational background and psychological state, the system is able to accurately identify the user's rehabilitation needs and generate a highly personalized rehabilitation plan. This personalized plan not only better meets the user's actual situation, but also improves the relevance

and effectiveness of the rehabilitation process. For example, for users with different occupational backgrounds, the system can recommend different rehabilitation training programs and vocational skills training, thus helping users to recover their vocational ability faster and return to work smoothly.

Another notable effect of intelligent recommender systems is the ability to dynamically adjust during the rehabilitation process. While traditional rehabilitation programs are often fixed and unchanging, the intelligent recommendation system is able to adjust the rehabilitation program in real time according to the feedback and data changes in the user's rehabilitation process. For example, the system can recommend a more suitable rehabilitation program or adjust the training intensity according to the user's rehabilitation progress, training effect and changes in psychological state. This dynamic adjustment not only improves the efficiency of rehabilitation, but also effectively avoids frustration in rehabilitation and maintains the user's motivation and drive for rehabilitation.

The application of intelligent recommendation system in vocational rehabilitation directly promotes the improvement of rehabilitation success rate and vocational reconstruction. Through personalized recommendations and dynamic adjustments, the system helps users recover their vocational abilities faster and more effectively. At the same time, the system can also provide users with career transition recommendations and training opportunities, helping users who have difficulty resuming their original careers to find a new career direction. The integration of these functions significantly improves the success rate of vocational rehabilitation, and the occupational stability and satisfaction of users after rehabilitation are also improved, reflecting the important role of intelligent recommendation systems in vocational rehabilitation.

The improvement of user satisfaction and experience is another important effect of the intelligent recommendation system in vocational rehabilitation. By providing personalized and dynamic rehabilitation programs, the system is able to meet the individual needs of the users, so that the users can feel the attentive service and professional support of the system. In addition, intelligent recommendation systems are usually equipped with intuitive user interfaces and convenient operation processes, so that users can easily access the recommendation results and rehabilitation suggestions, which improves the usability and user experience of the system. With the improvement of user satisfaction, the application of intelligent recommendation system in vocational rehabilitation has a broader prospect.

5. Conclusion

The application of intelligent recommendation systems in vocational rehabilitation demonstrates its significant advantages and potential. Through a personalized recommendation mechanism, the system is able to develop a precise rehabilitation program based on the user's health data, occupational background and psychological state. This personalized program not only meets the specific needs of the user, but also improves the relevance and effectiveness of the rehabilitation process, enabling the user to recover their vocational abilities faster and integrate into the workplace smoothly.

The dynamic adjustment capability of the intelligent recommendation system makes the rehabilitation process more flexible and adaptable. The system is able to monitor the user's rehabilitation progress in real time and adjust the rehabilitation program according to the feedback data, which avoids the limitations of the traditional fixed program and enhances the efficiency of rehabilitation and the motivation of the user. This dynamic adjustment not only effectively solves problems that may arise during the rehabilitation process, but also enhances the user's rehabilitation experience and satisfaction.

By improving the success rate of rehabilitation and the effectiveness of vocational reconstruction, the intelligent recommendation system brings new development opportunities to the field of vocational rehabilitation. The system is able to help users find a suitable career direction for themselves, provide necessary training and transition advice, and thus improve career stability and career satisfaction.

These effects are not only beneficial to individual users, but also provide new solutions for vocational rehabilitation services.

The application of the intelligent recommendation system significantly improves user satisfaction and overall experience. With an intuitive interface and convenient operation process, the system enables users to easily access recommendation results and rehabilitation suggestions, thus improving the usability and user experience of the system. In the future, with the continuous progress of technology and accumulation of data, the application of the intelligent recommendation system in vocational rehabilitation will be more extensive, providing better services to more users.

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