International Symposium on World Ecological Design
F. Ying et al. (Eds.)

doi:10.3233/FAIA240008

Research on Digital Medical Resource Scheduling Method Considering Data Interoperability

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Abstract. In the process of medical resource scheduling, it is difficult to ensure the comprehensive utilization rate of the corresponding resources due to the influence of the correlation between digital medical resource data. Therefore, research on digital medical resource scheduling method considering data interoperability is proposed. After realizing the representation of data and its processing process in digital medical data warehouse with the help of metadata, two ways of direct conversion and indirect conversion are adopted respectively, and an interoperability mechanism in the form of XML document is constructed for the original metadata stream of digital medical resources. In the specific scheduling process, according to the task status between the target node and the digital center, the digital medical resource scheduling center is determined, and the resource scheduling is realized by combining the promotion of different digital medical resource data to the main task operation ability. In the test results, the influence of increasing the number of task requests on the comprehensive utilization rate of resources is not obvious, and it is always stable in the range of 0.85-0.92.

Keywords. Data interoperability; Digital medical resources; Scheduling method; Metadata; XML document form; Interoperability mechanism; Task status; Dispatching center

1. Introduction

Influenced by the continuous development of Internet technology, the digitalization process has been promoted rapidly in all industries, and the execution efficiency of related resource management has been greatly improved [1-2] . As far as digital medical resources are concerned, its scheduling management has also begun to receive more and more attention. From the perspective of actual demand, this paper analyzes the fundamental purpose of resource scheduling, which is mainly to maximize the utilization value of resources. In view of this, some scholars have also carried out related research with resource scheduling as the core [3-4] .

Among them, the digital resource scheduling method based on NB-IoT system is one of the more common ways. From the perspective of related technologies of NB-IoT system, it objectively analyzes the main difficulties of digital resource scheduling. On the basis of fully considering the uplink frame structure of NB-IoT system [5-6] , it realizes the comprehensive analysis of the characteristics of scheduling units by means

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of multiplexing, and plans and schedules resources with the help of NB-IoT wireless network. Due to the low-power nature of the NB-IoT system, the device is in a sleep state and only wakes up at certain moments to communicate. This energy-saving mechanism will introduce a certain scheduling delay, which will affect the performance of some applications with high real-time requirements. The design of scheduling method improves the fairness of resource allocation to some extent, but it is obviously affected by the number of task requests [7-8] . In addition, the digital resource scheduling method based on VXLAN+SDN technology has also been widely concerned. This method fully considers the influence of basic resource dispersion on resource scheduling [9-10] , and introduces VXLAN+SDN technology in the multi-dimensional integration stage of digital resources, so as to improve the concentration of data information and reduce the difficulty of scheduling [11] . VXLAN+SDN involves network virtualization and software-defined networks, and requires sufficient network knowledge and technical support. The system performance and stability are highly dependent on the normal running of the network. If network problems or faults occur, resource scheduling will be adversely affected. The comprehensive utilization rate of resources under this scheduling method can reach a high level, but when the number of task requests reaches a certain scale, its performance will also decrease obviously. Lakhan A et al. according to the current development of healthcare, found that the application partitioning method based on static fog cloud has a limitation and cannot flexibly adapt to changes in dynamic environment, such as changes in network and compute node resource values. Therefore, they designed a deep neural network energy cost-efficiency partitioning and resource scheduling framework. The framework includes application partitioning, task sorting and scheduling components to realize the scheduling of hospital resources[12]. Deep neural network algorithms usually require large amounts of data to train and learn. Large amounts of data on the healthcare environment, resource usage and mission requirements need to be collected and processed. If the data collection is inadequate or inaccurate, the performance and accuracy of the algorithm will be affected.

Combined with the above analysis and design, this paper proposes a digital medical resource scheduling method considering data interoperability, and verifies the application value of the design method through comparative testing.

2. Digital medical resources scheduling method design

2.1. Digital Medical Data Interoperability Mechanism Construction

For digital medical data center, each independent component of data warehouse has its own unique metadata. Among them, for relational digital medical database, digital medical data dictionary, digital medical ETL tool conversion relational database and digital medical multidimensional tool knowledge base all have the above attribute characteristics [13-14] . However, it is worth noting that for some digital medical metadata that reflects the change of relationship, the components of data warehouse cannot contain such data. Combined with the above attribute characteristics, based on the data in the data warehouse and its processing process, this paper realizes the description of digital medical data with the help of metadata [15-16] . This paper analyzes the metadata of digital medical data in the whole data warehouse system from the

functional point of view, and its uses are mainly manifested in two aspects: on the one hand, the business of recording data items and the metadata describing information are one of the main sources of information based on users, which can give intuitive feedback on users' data usage [17] ; On the other hand, the management and maintenance of digital medical resource data can't be separated from the support of Kaiyuan data. Common data item storage and digital medical resource status analysis are all based on metadata [18] .

On the basis of the above, in order to realize the dispatching access to digital medical resources in the most effective way, in the process of constructing the interoperability mechanism of digital medical data, this paper takes XML document as the intermediate execution carrier, so that the original metadata stream of digital medical resources exists in the form of XML document [19-20] . In the specific implementation stage, combined with the characteristics of digital medical resources data information, direct conversion and indirect conversion are adopted respectively, as shown in Table 1.

Table 1. Implementation of Digital Medical Data Interoperability

Metadata Interoperability	Operation process	Key points	Implementation requirements
Direct conversion	The tool directly converts instances in XML exchange documents into tool specific objects, and there will be no implementation of CWM objects in memory at any time. Through this method, the definition is read in from a file, then tool specific objects are created, and the data is directly imported from the XML stream into the tool object.	The key to this method is the use of a certain type of mapping method. This interoperability method is most suitable when there is a one-to-one mapping between CWM objects and specific tool objects.	(1) The metadata interoperability process does not generate new metadata, or the metadata generated during the interoperability process is easy to obtain and manage. The interoperability process itself generates metadata. If the metadata management platform itself finds it difficult to access and control this metadata, the platform environment itself becomes a new source of metadata, and the goal of metadata management is difficult to achieve Cheng. (2) The metadata interoperability process does not rely on specific implementation techniques. There are various types of metadata sources, and there is no universal technology applicable to all situations. Therefore, separating the mechanism and implementation technology of metadata interoperability can improve the application value of the entire metadata management platform.
Indirect conversion	Usually, the tool first reads the CWM exchange document into a certain intermediate format, and then converts the intermediate format document stream into a tool specific definition format. The indirect conversion method is applicable to the metadata and data exchange between existing tools and tools that support CWM.	Firstly, the metadata exchange document is read into the platform through the XML Reader interface; Next, the corresponding CWM object instance is created in memory; Then, based on the target tool, call the corresponding CWM adapter to convert the CWM object into a tool specific object.	

According to the way shown in Table 1, the interoperability mechanism of digital medical data is constructed, which provides a reliable implementation basis for the subsequent digital medical resource scheduling.

2.2. Digital Medical Resource Scheduling

Combined with the interoperability mechanism of digital medical data constructed in part 1.1, this paper schedules digital medical resources according to the task status between the target node and the digital center, so as to realize the analysis of the scheduling relationship adjustment model structure [21-22] and ensure that the scheduled resources can be fully utilized. When decomposing the data tasks matched by the medical system, the influence of allocation and scheduling interval on the actual implementation of task data transmission and the influence of waiting time on scheduling efficiency in the space computing system are fully considered [23-24] . For the setting of data clustering center, this paper is based on the interoperability mechanism of digital medical data constructed in part 1.1, and through the interoperability relationship between different data, the calculation method of clustering center is expressed as follows

$$\overline{c_j} = \frac{1}{M}\sum x_i \qquad (1)$$

Among them, $\overline{c_j}$ stands for Digital Medical Resource Dispatching Center, M represents the digital medical resources under the interoperability mechanism of digital medical data x_i neighborhood number of the corresponding raster. By analyzing the digital medical resource data in different spaces, it can be found that the task group data with the same criteria can perform the corresponding resource scheduling according to the same standard or scheme. Therefore, this paper calculates the promotion of different digital medical resource data to the main task operation ability in the task scheduling stage, and the specific calculation method can be expressed as follows

$$S_{m\times n} = \begin{pmatrix} S_{11} & \cdots & S_{1n} \\ \vdots & \ddots & \vdots \\ S_{m1} & \cdots & S_{mn} \end{pmatrix} \qquad (2)$$

Among them, $S_{m\times n}$ represents the strength of digital medical resources to promote the operation ability of the main task. It should be noted that different resources have different promotion effects on different tasks, and under the reverse condition, the same resources may have different promotion effects on tasks [25-26] . This is also the key reason why most scheduling methods at this stage are difficult to effectively guarantee the comprehensive utilization rate of resources after scheduling.

On this basis, in the process of scheduling resources, this paper takes the digital medical resources which are closest to the cluster center and have the strongest ability

to promote the operation of the requested tasks as the scheduling object, so as to meet the objective needs and maximize the comprehensive utilization of resources.

3. Application testing

3.1. Test preparation

This paper compares and tests the practical application effect of digital medical resource scheduling method considering data interoperability. Collect data on the use of medical resources, including doctors, nurses, medical equipment, etc. at a large hospital over a three-year period. The data covers the use of various departments, time periods, personnel and equipment. Use Python's pandas library to clean and process the data, remove outliers and missing values, and standardize the data to eliminate dimensional effects. The digital health resource dataset is presented in tabular form, and the information covered therein is shown in Table 2.

Table 2. Statistical Table of Test Data Information

number	resource classification	Match Database
1	Composition of digital resources	machine_events
2	Specific attribute information of medical resources	machine_attributes
3	Task events	job_events
4	Work events	task_constraints
5	Resource usage	task _usage

Combined with the information shown in Table 2, it can be seen that the prepared test data mainly includes five files to cover different types of digital medical resource information. Considering the influence of data consistency on the scheduling effect, this paper uses python language to preprocess the task_usage file data in the test digital medical resource data set and convert it into the same data form as the four data sets.

In the specific testing process, 70% of the tested digital medical resource data sets are used as training data, and the remaining 30% of the tested digital medical resource data sets are used as test data. For the preparation of the control group, the scheduling methods are the digital resource scheduling method based on NB-IoT system and the digital resource scheduling method based on VXLAN+SDN technology. By comparing and analyzing the application effects of different scheduling methods, the performance of the design method in this paper is objectively evaluated.

3.2. Test results and analysis

When analyzing the test results of different methods, this paper takes the comprehensive utilization rate of digital medical resources as a specific evaluation index, and sets the independent variable as the number of Pod task requests, so as to

realize the simulation of different scheduling scenarios. Among them, the test results of different methods are shown in Figure 1.

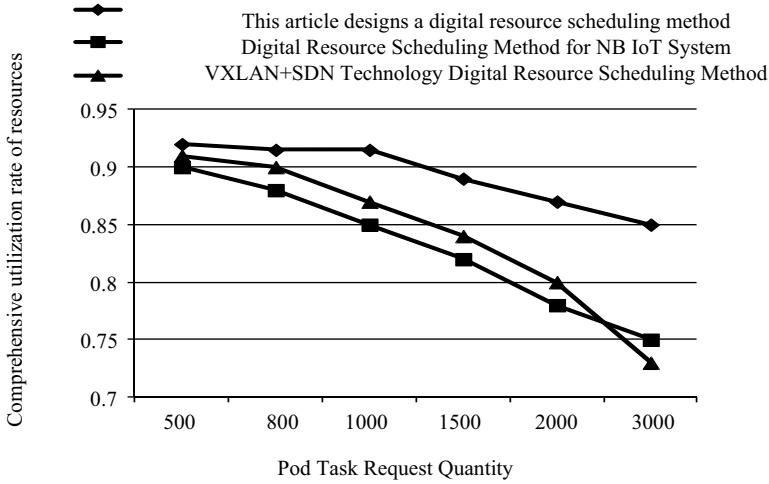

Figure. 1. Comparison chart of test results of different methods

Through the analysis of the test results shown in Figure 1, it can be seen that there is no obvious difference in the comprehensive utilization ratio of resources under the three resource scheduling methods when the number of Pod task requests is small. When the number of Pod task requests increases gradually, the resource utilization ratio of the corresponding resource scheduling methods shows different trends respectively. Among them, in the test results of the digital medical resource scheduling method designed in this paper, the influence of the increase in the number of Pod task requests on the comprehensive utilization rate of resources is not obvious, and it is basically stable in the range of 0.85-0.92, which shows that the digital medical resource scheduling method designed in this paper can realize the reasonable allocation of resources according to the actual situation and ensure the balance of resource allocation.

In the test results of digital resource scheduling method based on NB-IoT system, the resource utilization rate decreases with the increase of the number of Pod task requests. When the number of Pod task requests increases from 500 to 3000, the corresponding resource utilization rate decreases from 0.90 to 0.75, with an overall decrease of 0.15. In the test results of digital resource scheduling method based on VXLAN+SDN technology, when the number of Pod task requests is less than 1,000, the resource utilization rate is less affected by its growth, only 0.04. However, when the number of Pod task requests reaches more than 1,000, the resource utilization rate is significantly increased. When the number of Pod task requests reaches 3,000, the corresponding resource utilization rate is only 0.73. This is lower than 0.02 for the digital resource scheduling method based on the NB-IoT system, and lower than 0.12 for the digital resource scheduling method designed in this paper. Based on the above test results, it can be concluded that the digital medical resource scheduling method considering data interoperability designed in this paper can realize the reasonable scheduling of resources and maximize the comprehensive utilization rate of resources.

4. Conclusion

For digital medical resources data information, affected by the interoperability of the data itself, how to ensure the comprehensive utilization of resources has become one of the most important problems in the process of resource scheduling. In this paper, the research of digital medical resources scheduling method considering data interoperability is put forward. On the basis of constructing the data interoperability mechanism of digital medical resources, the reasonable allocation and scheduling of resources are realized in combination with actual needs and conditions, and the purpose of improving the comprehensive utilization rate of medical resources is effectively realized. With the help of the design and research of this paper, I hope to provide valuable reference for the development of related resource scheduling management.

In this method, the resource scheduling center is selected according to the task state between the target node and the digital center. However, in a large-scale digital health system, choosing a suitable resource scheduling center can be challenging. More complex algorithms and decision mechanisms are needed to select the best resource scheduling center to improve the overall scheduling performance. In order to solve the above limitations, for the problem of resource scheduling center selection, the algorithm will be improved and optimized in the future, using heuristic algorithms, machine learning and other methods, and considering more factors (such as resource utilization, delay, bandwidth, etc.) to select the optimal resource scheduling center and improve the accuracy and performance of selection.

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