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Optimization of Balanced Distribution of Online and Offline Biochemistry Teaching Resources Utilizing Machine Learning Algorithms and Big Data

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Abstract: - Utilizing machine learning algorithms, the current conventional optimization methods for balanced allocation of teaching resources are enhanced. These methods primarily focus on predicting the current network resource load capacity without calculating the adaptation factor, often leading to suboptimal allocation outcomes. To address this issue, we propose a balanced allocation optimization approach for online and offline biochemistry education resources, taking into account the importance degree and big data. This approach calculates the probabilistic importance of teaching resources and the user delay in distinct modes to identify the optimal balanced allocation of teaching resources. Our experimental results comfirm that this approach achieves a higher resource utilization rate and a more desirable allocation effect compared to previous methods.

Keywords: Machine Learning Algorithms, Probabilistic Model, Online and Offline, Teaching Resources, Balanced Distribution.

I. Introduction

Educational resources have all kinds of things including educational funds, facilities, teaching and administrative personnel, etc[1]. Machine Learning Algorithms have found widespread applications in the field of higher education, assisting in various tasks and enhancing the efficiency and quality of education[2]. Having abundant educational resources is an important criterion to measure or judge the comprehensive strength and teaching quality of a school, and as a kind of resources with the attributes of public goods, it has strong public welfare and social nature, and is an important part of social equity, which is the extension and embodiment of social equity in the area of higher education. The degree of achieving educational equity in a society is a reflection of the overall progress of society and an important indicator of a country's educational development level. Higher education resources are the basic guarantee and basic condition for the development of higher education[3] . The distribution of the resources should not only reflect fairness but also pay attention to efficiency, and guarantee people's right to obtain educational equity in general. There are efficiency problems in the redistribution of educational resources by higher education institutions themselves. First of all, science is emphasized over literature, and the construction of humanities and social sciences is not given the necessary human and material resources to support. Science and engineering subjects take up most of the educational resources of the university, and frequently replace the equipment that is not necessary to replace, so that some educational resources cannot play their proper efficacy, which leads to the waste of a lot of educational resources. Secondly, with the increase in the number of newly added majors and the expansion of university scale, the colleges of science and engineering compete for the limited teaching resources and laboratory equipment in schools from the consideration of the development of their own majors and disciplines, and some resources are duplicated and set up with low utilization rate, which leads to the relative excess of some resources and the lack of resource sharing among various departments in schools. The uneven scale of colleges and universities, the lack of due autonomy in school operation and the excessive administrative power within colleges and universities causing low teaching efficiency. Influenced by bad bureaucratic thoughts, some colleges and universities have the problem of academic bureaucratization at present. The number of administrative staff exceeds the number of front-line teachers in

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teaching, and the school resources they occupy exceed those of front-line teachers to a certain extent. This kind of unreasonable personnel quantity and resource allocation between front-line teachers and school administrators seriously leads to the waste of resources[4] . Meanwhile, the teaching resources do not reflect the principle of "student-oriented". As the scale of college students expands, the construction of campus infrastructure need to be built in order to alleviate the tension of teaching resources such as classrooms, dormitories, laboratories and libraries. Some colleges make use of the preferential policies of the state for education to expand their campuses lead to a improper teaching resources distribution. In the teaching experiments of many universities, the allocation of teaching resources is adopted to meet actual needs of teaching resource library construction. FEI, XUE, and others use the LDA model to scan documents and build semantic model with teaching resources. By developing potential semantic themes of documents, adding teaching resource retrieval and sharing modules, the design and construction of teaching resource libraries are completed. In the period of applying models to process teaching resources, a large amount of computation is involved, resulting in low efficiency in data resource library construction[5]. For improving the effectiveness of online teaching, Li Peixian and others built a widely adapted Deformation monitoring online course resource database based on Moodle open source online education platform. By designing different teaching exchange modules, test question databases, case databases, and combining OBE teaching philosophy, Deformation monitoring technology online course teaching content was integrated to build a teaching resource database. However, in the process of communication module design, Due to the limitation of communication content to existing online teaching content, the comprehensive effectiveness of balanced allocation of educational resources needs to be improved[6]. To sum up, it can be seen that when conducting large-scale and experimental resource allocation, due to the characteristics of openness and complexity, resource allocation is subject to various external factors, which can easily lead to low signal-to-noise ratio problems and cause certain difficulties in resource allocation during the teaching process. Therefore, this article proposes an optimization method for balancing the online and offline allocation of biochemical teaching resources based on importance and big data.

II. Probabilistic importance Calculation of Biochemistry Teaching Resources Online and Offline

The article takes online and offline teaching resources in biochemistry as an example to explore the principles of resource allocation. Firse, we calculated the proportion of each resource processing node in each dimensional resource, The ratio of allocated resources per dimension to all allocated resources of its node, the remaining value of resources of the node and the dynamic ratio of each resource are calculated. Then, the balanced allocation of biochemistry teaching resources is completed. The specific steps are described in detail below:

Firstly, assuming that the number of resource processing nodes is represented by c and R represents the system resources of each resource processing node in dimension m, the proportion of total resources of each resource processing node in the same dimension needs to be calculated as formula (1)[7] .

$$\gamma(g) = \frac{R \otimes c}{o(f)\mu(K)} \tag{1}$$

Where, $\theta(k)$ represents the set of tasks selected from the set of tasks forming k disjoint subsets, $\mu(K)$ represents the amount of resources in the kth dimension of the resource processing node, and $o(f)$ represents the resources required for each task[8] . Then we need to calculate the probabilistic importance of teaching resources, which is the degree to which the change in unreliability (probability of failure) of the resource teaching unit causes the change in unreliability (probability of failure) of a certain resource teaching system. The method and steps for calculating the probabilistic importance of teaching resources are as follows[9] .

(1) Establish the FTA model of teaching system. According to the definition of probabilistic importance model of teaching resources, it is known that the key to solving the probabilistic importance is to analyze the logical relationship between the failure event (bottom event) in the teaching resource unit and the failure of teaching system (top event). Fault tree analysis method, abbreviated as FTA, is a special inverted tree logical causality graphical deduction method starting from system unreliability (i.e., failure), which can express the logical relationship between top and bottom events under a clear graph, practical, flexible and intuitive[10] .

(2) Construction of structure function of resource teaching system. The prerequisite for quantitative analysis such as importance of FTA is the mathematical quantitative description of the fault tree. Assume that the bottom events are independent of each other; the resource teaching units and the system have only two conditions, right

and wrong; and the resource teaching unit lifetime is exponentially distributed. Let x_i denote the state variables for bottom events and Φ denote the ones for top events, with the following definitions (2).

$$x_i = \begin{cases} 1, \Phi \geq 0 \\ 0, \Phi \leq 0 \end{cases} \tag{2}$$

Due to the fact that the top event state is completely determined by the bottom event state in the fault tree, the following expression is obtained by formula (3).

$$\Phi(X) = \Phi(x_1, x_2, ..., x_n) \tag{3}$$

The structural function $\Phi(X)$ of FTA is a Boolean function that represents the state of the system, and its independent variable is the state of the constituent units of the system. Based on the above definitions of fault trees with AND or gates, their corresponding structural functions can be derived. Then, based on the logical relationships established by the FTA and the with and or gate structure functions, the structure function of the system can be constructed directly at[11] .

(3)Derive the calculation formula for the highest probability of event occurrence in the resource teaching system. Calculate the probability of the bottom event *i* occurring, that is, calculate the expected value of the random variable $x_i(t)$, as shown in the following formula (4).

$$E(x_i(t)) = F_i(t) \tag{4}$$

where $F_i(t)$ denotes the probability of event *i* occurring in time [0, 1], i.e., the unreliability of the *i*-th resource teaching unit. Then, calculate the probability of the top event occurring in the fault tree composed of *i* bottom events, i.e., the unreliability of the resource teaching system, as shown below.

$$F_s(t) = E(\Phi(X)) \tag{5}$$

The importance of teaching resources at each resource processing node can be calculated by the above steps (5), which can help to optimize the subsequent balanced allocation of teaching resources[12] .

III. Calculation of User Delay in Different Modes

We assume that *p* represents the primary users and *s* represents the secondary users. pU_s and pU_D represent the transmission and reception nodes of the *p,* respectively. R_P R_S and R_{PS} respectively represent the corresponding channel rates. SU_S R_{SP} represent the channel rates from the secondary user's transmitting resource node SU_S to the pU_s . R_{CP} , the equivalent packet transmission rate of *p* after allocation[13] , is calculated using equation (6).

$$R_{CP} = \frac{pUs \oplus pU_D}{SU_S[R_S + SU_D]} \tag{6}$$

Equation (7) is used to form the average delay of the primary user's resource usage[14] .

$$E\|T_{NC-S}\| = \frac{E[x_{nc}]}{P_{NC-S}}\lambda_s \tag{7}$$

Where, $E[x_{nc}]$ means the average service time of *s*. P_{NC-S} represents the ratio of resource utilization rate of *s* to the departure rate of *p* in the unassigned model. λ_s is the resource utilization rate of user.

During the resource usage process in allocation mode, secondary users provide resource services to the primary user until the queue of the primary user is empty. Due to the existence of resource allocation protocols, the primary user will not forcibly interrupt the resources being used by the secondary user. Therefore, using equation (8) we can obtain the average delay of the *p*'s resource usage in this pattern[15].

$$E\|T_{BE-P}\| = \frac{E\|T_{NC-P}\|}{R_{PS}} \tag{8}$$

In summary, during the process of optimaizing the allocation of online teaching resources, a resouce allocation delay model is formed in the network, and user delays under different modes are obtained, which is the foundation for optimizing the allocation of online teaching resouces.

IV. BALANCED AND OPTIMIZED ALLOCATION OF TEACHING RESOURCES

From the perspective of efficiency, the optimal allocation of biochemistry education resources refers to the rational allocation of limited educational resources within the region, achieving optimal allocation, cultivating more talents for society, and promoting the balanced development of biochemistry education. From relevant information, it can be seen that there is a certain relationship between each component of education and the investment in education. Some economic theories suggest that the input of education can be calculated its value by output, which is the ratio of input and output. If the ratio between the amount of input and output of education is larger, it means that the ratio of output is larger, which indicates that this kind of education resource allocation is more reasonable. To achieve the maximum output of biochemistry education resources in a certain city, the efficiency of education resources in that city should be improved. That is, from the district side, the productivity of each indicator between districts and counties should be as large as possible; within districts and counties, the productivity of each indicator between schools should also be as large as possible. Therefore, the objective function to improve the productivity of education indicators for the district or individual school is expressed as shown below (9).

$$\max ef_1 = \frac{T_{ij} + NT_{ij}}{P_{ij}} \tag{9}$$

Where T_{ij} represents the education indicator output rate, N represents the individual teacher output rate, and P_{ij} represents the teacher-to-student ratio. The objective function represents the optimal ratio of full-time teachers to students for the indicator of teacher-student ratio, i.e., within a certain range, maximize the ratio of full-time teachers to students in the school, thereby maximizing the number of students taught by teachers and improving the efficiency of the teacher-student ratio indicator. Whether the indicators are too large or too small can have a certain impact on the teaching quality. On the one hand, if there are too many students and too few teachers in the class, the quality of teaching cannot be guaranteed; on the other hand, if there are too few students and too many teachers in the class , it will cause a waste of teacher resources, which means that the role of teachers is not fully utilized and is not conducive to the establishment of a learning atmosphere[16] .

In the process of configuring biochemical mobile resources, fusion in the node joining method calculates the actual load difference between each resource processing node based on the average load difference degree of physical nodes, and obtains the load imbalance degree of the current set of physical machines in the resource center, based on this, calculates the matching degree between physical and virtual machines in the resource center, and constrains the resource requirements of virtual machines within the resource capacity of physical machines. The specific steps are described below.

Assuming r represents the resources owned by the node and u represents the resource utilization rate of the node, the actual load difference between each resource processing node is calculated as follows (10).

$$wload(n,t) = r \times u \otimes \frac{fr(n,t)}{aloaddiff} load(G^s,t) \tag{10}$$

Where $fr(n,t)$ represents the amount of free resources of the physical nodes themselves, $load(G^s,t)$ represents the average load variance of the physical nodes, and $aloaddiff$ represents the current total load of the mobile network. In summary, it can be seen that in the process of balancing and optimizing the allocation of teaching resources in mobile networks, the integration of the node joining method calculates the actual load difference between each resource processing node based on the average load difference degree of physical nodes, obtains the load imbalance degree of the current set, calculates the matching degree between physical machines and virtual machines in the resource center, and constrains the resource demand of virtual machines. The resource demand of virtual machines is constrained within the resource capacity of physical machines, which lays the foundation for balanced and optimized allocation of teaching resources in mobile networks.

In the process of balancing and optimizing the allocation of biochemical resources, calculate the current biochemical resource consumption indicatiors based on the resource requirements of the virtual machine after computing constraints, and the resource allocation function is obtained to give the adaptation factor between the resource consumption index and the resource processing node performance index, which is used to complete the balanced and optimal allocation of biochemistry resources. The specific steps are detailed below:

Suppose, by H representing the resource hotness and m representing the number of all cases in which the node interacts with the resource, the formula for calculating the current biochemical resource processing consumption is given below, based on the resource demand put into the virtual machine after calculating the constraint represented by $F(\Phi)$.

$$U=\frac{H\otimes F(\Phi)}{f_j p_j} \tag{11}$$

Where, f_j represents the amount of time consumed by the resource in the *j*-th interaction case, and p_j represents the probability of the *j*-th interaction case occurring for the resource. From the calculation result of equation (11), it can be shown that p_j represents the probability of the jth interaction case of the resource occurring can be obtained by dividing the resource access heat by the access heat to all resources, so the current biochemical resource consumption index can be calculated. By defining the current performance metric of the mobile networks as the ratio of standard latency represented by S1 to actual latency represented by v1, the biochemical resource allocation function can be calculated.

Since the biochemical resource handling node performance index and the resource consumption index are two completely different units of measure, an adaptation factor represented by a is given using equation (12).

$$a=\frac{\sum_{i=1}^{m} C_i}{P_j} C\times e \tag{12}$$

In the equation, C_i represents the resource processing right, and e represents the possibility coefficient of increasing matching. The results calculated based on equation (12) can complete the balanced and optimal allocation of biochemical teaching resources under the mobile network.

V. Testing and Analysis

A. Preparation

To demonstrate that the optimization effect of the online and offline biochemistry teaching resource balance and configuration optimization method based on importance and big data is superior to traditional teaching resource balance and configuration optimization methods, after the theoretical design is completed, an experimental section is constructed to verify the actual optimization effect of the method. To improve the reliability of experimental results, we chose two conventional methods as the experimental control, namely, the particle swarm algorithm-based and the ant colony algorithm-based methods of balanced allocation of teaching resources.

The C1oudSim was used to building a simulation platform for balanced allocation of biochemistry teaching resources. The data comes from the tutorial website of a teaching team. Table 1 shows the specific parameters..

Table 1: Experimental Hardware Platform Parameter Settings

parameter	value
Motherboard	PSDFGS-AM
Processor	Pentium E6300
Memory	5.6GB
Main Hard Drive	500GB
Video card	512MB

The performance of three optimization methods for balanced allocation of teaching resources was tested using an experimental hardware platform, and the resource utilization rates of the three methods were compared under different resource requirements.

B. Analysis

The evaluation indicator selected for the test is the optimization performance under different optimization methods, with specific measurement criteria being the scale of resource utilization, The higher the resource utilization rate, the better the actual balanced allocation performance of representative methods. See in Figure 1 for details.

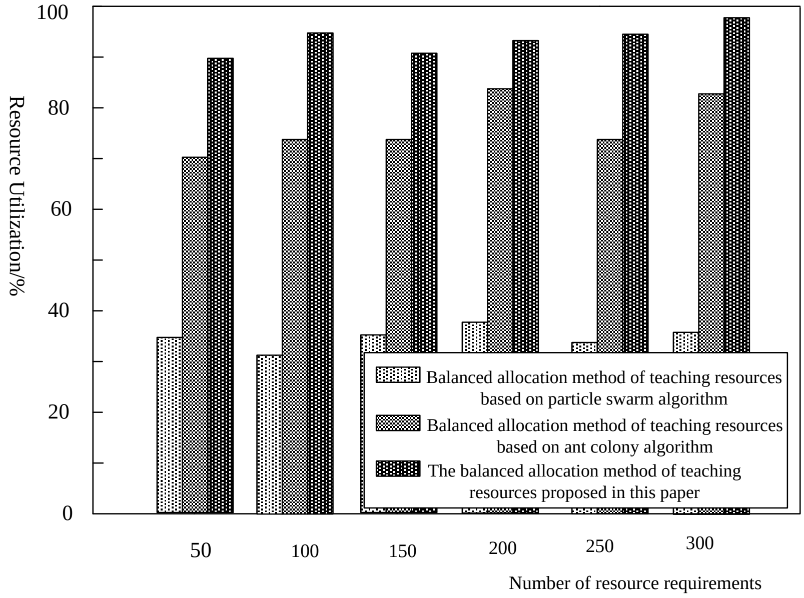

Figure 1: Changes in resource utilization

From Figure 1, different balanced allocation methods have different resource utilization rates under different resource demand quantities. Numerical comparison shows that the proposed balanced allocation optimization method has significant advantages in resource utilization, with a resource utilization rate of over 80%, while the two traditional balanced allocation optimization algorithms have lower resource utilization rates. This is mainly because when using the balanced allocation method of educational resources in this article, the node joining method is first used to define the load imbalance of a group of physical machines in the resource center, calculate the matching degree between virtual machines and physical machines, and provide the constraint range of virtual machine learning resource requirements, so as to guarantee the comprehensive effectiveness of balanced allocation of educational resources.

VI. CONCLUSION

In this paper, we address the problem that when the current method is used for resource balanced allocation, the computational resource consumption index and node performance index cannot be calculated accurately, and there are limitations in resource balanced allocation. Incorporating machine learning algorithms, we have refined the balanced online and offline allocation optimization method for biochemistry teaching resources, leveraging the predictive power of these algorithms to further enhance the accuracy and efficiency of resource allocation.

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