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A decision model for resource allocation optimization based on linear programming in school affairs information technology

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Abstract This paper carries out linear planning for school affairs information, aiming to optimize the allocation of school affairs information resources and achieve the goal of school affairs informationization. Based on the content of school affairs information, current problems and the necessity of resource allocation, this paper constructs a linear planning model, based on which a dyadic model is established to construct a school affairs information resource allocation model based on linear planning. Through relevant experiments. Test the resource allocation effect of this paper's model. The average number of cases of this paper's model to solve the optimal solution is comparable to other algorithms, but the computation time is significantly shorter than that of other algorithms, which has a greater advantage of speedy solution degree. In the experiments of small-scale and large-scale problems, the resource allocation model based on linear programming in this paper has the lowest relative deviation index, and has the most excellent effect in solving the optimal solution.

Index Terms linear programming, pairwise programming, optimal resource allocation, school information

I. Introduction

In recent years, the state has attached increasing importance to the development of education informatization, and the promotion and popularization of school affairs informatization management in colleges and universities has been more effective [1]. It specifically refers to the school in order to break through the time and space limitations, better serve the teachers and students, and strengthen the inter-school contact and the use of high-tech information technology and digital integration technology, the establishment of intelligent, networked school affairs platform and the implementation of the process of management, operation and maintenance services [2]. In terms of its extension, school affairs informatization management aggregates a variety of factors such as education informatization, e-government, big data mining, cloud sharing, etc., and at the same time, its radiation scope also involves a variety of interest groups [3]-[5]. The implementation of school informatization management is conducive to promoting the development of school administrative functions, promoting the flattening and rationalization of the administrative organizational structure, the scientific and flexible management decision-making, thus activating the development and innovation of the entire education system [6]-[8].

With the continuous development of education informatization, for example, the shortage of resources, irrational configuration and irregularities in the management of teaching affairs and other problems of higher education have gradually emerged [9]. For this reason, the resource allocation of colleges and universities has an important impact on their overall schooling level, teaching quality and sustainable development [10]. Scientific and reasonable resource allocation can maximize the efficiency of the use of educational resources, reduce the waste of resources, and ensure that the quality of teaching and the quality of personnel training is steadily improved [11], [12]. At the same time, effective resource allocation can also promote the cooperation and communication between schools and enterprises, universities and colleges, and promote the development of grassroots open universities to a new level [13], [14]. Therefore, in the context of school affairs information management, intelligent technology can be used to stage the design of the decision-making system for resource allocation, promote the formation of a complete electronic school affairs development system between schools and bureaus, and achieve the optimal allocation of educational resources [15]-[17].

In order to promote the digitalization and informatization reform in the field of education, this paper optimizes the allocation of resources for school service information through the method of linear planning. The author first classifies the school service information and fully analyzes the current problems of school service informatization, so as to point out the necessity and suggestions for the resource allocation of school service information service. Then, this paper describes the information service problem. Describe the model parameters before performing linear programming, substitute the school affairs information data into the linear programming model, and establish the dyadic model on the basis of the original linear programming model to construct the school affairs information resource allocation model based on linear programming. Finally, the performance of the model in this paper and its practical performance on small-scale and large-scale problems are examined through experiments.

II. Resource allocation for school information and school information services

II. A.Information on school affairs

This paper summarizes the school affairs information based on the study of related materials. The research object of this paper is based on institutions of higher education, and the allocation of school affairs information resources in the following are described as an example of colleges and universities.

The school affairs information open to the public mainly includes:

(1) Basic school information. The size of the school, the setup of school enterprises and faculties, the ideology and purpose of school running, school leaders, school constitution, school development plan, annual work plan and key work arrangements and other information.

(2) Enrollment and employment information. The school's annual enrollment plan and admission conditions, the announcement of the admission list, admission information query, enrollment of professional catalogs, the employment of graduates of each session of the employment guidance, scale, structure, employment rate, employment flow, the quality of employment of college graduates and other information.

(3) Teaching quality information. Number and structure of undergraduates, graduate students, teachers. Teaching situation of professors. Information on the setting of majors, the addition of majors, the suspension of majors, the basic situation of courses offered by the school, and the report on the quality of teaching.

(4) Academic information. Basic requirements for granting doctoral, master's, and bachelor's degrees. Methods and basic requirements for the examination and recognition of personnel with equivalent qualifications for doctoral and master's degrees to be conferred. Information on the examination and approval methods for new master's or doctoral programs. Information on academic and pedagogical exchanges with other schools in the international arena, and the status of joint programs between domestic and foreign schools.

The information on academic affairs disclosed to campus personnel mainly includes:

(1) Student work Management methods of student registration. Rules for evaluating students' school-level scholarships, national-level scholarships and various kinds of grants. Measures and requirements for applying for student loans and regulations for work-study applications. Penalty rules for students violating school rules. Information on channels for student complaints. Timely release of information on academic exchanges and major lectures.

(2) Faculty and staff work. It mainly includes the social part-time jobs of school-level leading cadres. Appointment and dismissal of middle-level cadres on campus. Faculty and staff position setting and management regulations, faculty and staff work responsibilities and obligations, technical title level division. Teaching staff dispute resolution and other information

(3) Financial information. Financial and asset management system. School funding sources. Annual funding budget program. The use and management of school funds and donated funds or property. Information on fees and charges, the basis of fees and charges, fees and charges, and the way to complain.

(4) Welfare and security and logistics management information. Includes information on the management of faculty and staff apartments and student dormitories and other life notification categories.

II. B.Problems faced by school affairs informatization

(1) Lack of unified planning for development

The university's campus informatization construction should have been an organic whole. However, the discontinuity of informationization construction due to the incoherence of educational investment; coupled with the relatively loose relationship between university faculties and departments, it also leads to an easy lack of unified planning in carrying out campus informationization construction, making it difficult to process information at a higher level, such as information mining, decision support, and so on.

(2) Lack of effective information sharing

Campus information in the university is like an enterprise, which should be an organic whole. However, as the university itself is in a period of change in education reform, the application system is developed and completed by different groups of people at different times, lacking global system planning. Data sharing among application systems also relies on backward disk or even paper media for inefficient information transfer, making it difficult to realize effective sharing of university affairs information. In addition, although individual systems run on computers connected to the campus network, their own mode of operation is the personal computer mode, making it difficult to complete information sharing with other systems. The lack of effective sharing of information has a significant impact on the efficiency and accuracy of the entire campus network application system.

(3) Lack of effective application integration

The application system of the university should also be an organic whole. Also due to the reasons mentioned earlier, as well as the fact that the application systems may be developed using different software platforms, coupled with the lack of application access interfaces under unified planning, there is a lack of integration among the application systems. The same user, accessing different application systems of the campus network, may need different passwords or even different identifiers. The application systems cannot directly access each other's data and functions, and sometimes human processing, such as data exchange, is required.

(4) Lack of unified interface for users

For different application systems, users need to log in and access them separately, and there is a lack of unified interface for accessing resources and applications. In the face of a wide range of application systems, it is difficult for users to find what they need, and the degree of humanization is low.

II. C.Resource allocation for school affairs information services

The configuration of school affairs information resources contains a huge amount of content, and this subsection takes the configuration of educational resources as an example.

(1) Digital Management and Integration of Educational Resources

With the help of digital management, traditional paper-based educational resources are transformed into electronic resources that are easy to store, transfer and share. Through the construction of a unified digital resource library, teaching materials, lesson plans, courseware, etc. are categorized in an orderly manner, making them easy to retrieve and utilize. Teachers and students can freely access the resources they need according to their individual needs, thus enhancing the efficiency of teaching and learning.

(2) Individual customization of personalized teaching resources

Personalized teaching resources are tailored to students' unique differences and learning needs. Based on students' interests, learning styles, knowledge levels and other factors, the system can intelligently recommend appropriate teaching materials, courses and learning paths. These tailor-made resources can better meet students' learning requirements and promote the improvement of learning effect and interest.

(3) Integration and cross-utilization of interdisciplinary resources

Create a mechanism for interdisciplinary integration and cross-utilization of resources in different subject areas. For example, history and literature, science and art disciplines can be combined with multimedia technology and interdisciplinary teaching mode to show students a richer and more diverse knowledge. This interdisciplinary integration of resources can expand students' disciplinary horizons and cultivate the development of innovative thinking.

(4) Evaluation and Adaptation of Educational Resources Utilization Efficiency

On campus, the allocation of educational resources is constantly evaluated and adjusted for effectiveness. Through data analysis and assessment tools, it is possible to understand the actual utilization of different resources in teaching and learning, and uncover possible problems and shortcomings. According to the assessment results, the allocation strategy of resources can be adjusted in time to guarantee the rational application and optimal allocation of resources.

(5) Full support for teacher training and resource development

As the main users and creators of educational resources, teachers need to adapt to the evolution of the campus environment. Schools can provide relevant training to assist teachers to become proficient in digital teaching tools and resource management platforms, and to strengthen their skills in resource development and utilization. At the same time, schools can encourage teachers to participate in the development of resources to promote diversity and innovation in educational resources.

Through the above approaches, campuses can skillfully achieve the integration and optimal allocation of educational resources, bringing richer, more convenient and personalized learning resources to teachers and students, and providing strong and solid support for efficient education.

III. School affairs information resource allocation model based on linear programming

III. A. Raising the issue of information services

III. A. 1) Description of the problem

The richness of information resources is to a certain extent demonstrated by the information service capacity of information service enterprises, while different requirements arising from the level of program technology and other aspects will consume a certain amount of information service capacity. Information service enterprises need to allocate information resources effectively according to the relationship between program technology level and information service capacity to fully satisfy customer needs.

III. A. 2) Description of model parameters

Assuming that an information service enterprise needs to provide information service programs for n clients in a program period, the composition of the parameters of information service programs are:

x_i - denotes the technical level parameter requirements of the i th client enterprise for the program, $i = 1, 2, 3, \cdots, n$.

p_i - denotes the marginal value of the solution for the i th client firm, reflecting the different marginal values resulting from the different technological levels of the solution.

c_i - denotes the information cost of developing the information service program for the i th client firm.

b_j - denotes the j th information service capacity for which an information service program was developed, but there was a surplus or lack of it during the development of the information service program; ($b_1, b_2, \cdots, b_k$ are the $1, 2, \cdots, k$ information service capabilities that satisfy the need to develop an information service program; $b_{k+1}, b_{k+2}, b_{k+3}, \cdots, b_m$ are the $k+1, k+2, k+3, \cdots, m$ types of information service capacity that cannot be fully satisfied with the development of an information service program; $b_{m+1}, b_{m+2}, b_{m+3}, \cdots, b_r$ are the $m+1, m+2, m+3, \cdots, r$ types of information service capabilities that do not satisfy the development of the information service program at all. ($j = 1, 2, 3, \cdots, r$).

s_j - denotes the j th type of information service capacity that needs to be rented for the development of an information service program during the plan period.

OR_j - denotes the j th type of information service capacity that can be leased out during the plan period relative to the development of the information service program.

q_j - denotes the market value of the j th type of information service capacity to be rented in or out.

e_j - denotes the cost of using a unit of information service capacity.

M_{ij} - denotes the demand for the unit of information service capacity for the development of the i th client enterprise program.

$M_{ij}x_i$ - then denotes the demand for the j th total information service capacity for the development of the i th client enterprise program.

Where the value of x_i is determined by the customization needs of the client enterprise, and the consumption of information resources is mainly determined by the information service capacity parameter b_j, the technology level parameter x_i, and the information service capacity parameter b_j are the factors affecting the allocation of information resources.

III. B. Model for optimal allocation of information resources

III. B. 1) Linear Programming Models

Linear programming problems have various forms [18], [19], but all of them involve maximizing or minimizing an objective function under a set of linear constraints, which can be equations or inequalities, and can usually be described by a mathematical model as:

$$(LP)\begin{cases} \max/\min f(x_1, x_2, \cdots, x_n) = \sum_{j=1}^{n} c_j x_j \\ s.t. \sum_{j=1}^{n} a_{ij} x_j \le (\ge, =) b_i, i = 1, 2, \cdots, m \\ x_j \ge 0, j = 1, 2, \cdots, n \end{cases} \tag{1}$$

where x_j is the optimization variable, $f(x_1, x_2, \cdots, x_n)$ is the objective function, c_j is the benefit or cost coefficients, $g(x_1, x_2, \cdots, x_n) = \sum_{j=1}^{n} a_{ij} x_j$ is the constraint function, a_{ij} is the technical coefficients and b_i is the constraint values.

Employing vector and matrix notation for representation, equation (1) can be rewritten as:

$$(LP)\begin{cases} \max/\min cx \\ s.t. Ax \le (\ge, =) b \\ x \ge 0 \end{cases} \tag{2}$$

where $c = (c_1, c_2, \cdots, c_n)$; $A = (a_{ij})_{m \times n}$ is the $m \times n$ -dimensional coefficient matrix of the constraints, in general $m < n$; $b = (b_1, b_2, \cdots, b_m)^T$; $x = (x_1, x_2, \cdots, x_n)^T$.

In practice, there are many different forms of linear programming modeling, but any of them can be equivalently transformed into other forms. Therefore, we generally study the model as described below:

$$(LP)\begin{cases} \max f(x) = (p - c)x \\ s.t. Ax \le b \\ x \ge 0 \end{cases} \tag{3}$$

Based on the description of the linear programming model above, this paper applies linear programming to the environment of university affairs informatization, considers the customized demands from teachers and students and the limitations of the university's own information resources, and establishes a parameter-containing linear programming model about the optimal allocation of the university's academic information resources from the perspective of satisfying the demands of teachers and students and based on the principle of the optimal overall interests of the university.

Assuming that the university reaches cooperative deals with other external enterprises during the planning period, the surplus information service capacity can be fully rented out and the missing information service capacity can be fully rented in, the optimization objective of the university is to obtain the maximum benefit by adjusting the information service capacity rented in and rented out. From the description of model parameters in section 3.1.2, the objective function is:

$$\begin{aligned} R = & \sum_{i=1}^{n} (p_i - c_i) x_i + \sum_{j=1}^{k} q_j \left(b_j - \sum_{i=1}^{n} M_{ij} x_i \right) \\ & - \sum_{j=k+1}^{m} q_j \left(\sum_{i=1}^{n} M_{ij} x_i - b_j \right) - \sum_{j=m+1}^{r} q_j \sum_{i=1}^{n} M_{ij} x_i \end{aligned} \tag{4}$$

Since the revenue from renting out the surplus information service capacity of this university $\sum_{j=1}^{k} q_j b_j$ and the cost of renting in a portion of the lacked information service capacity $\sum_{j=k+1}^{m} q_j b_j$ are constants, they do not have an effect on the value of x . Thus the objective function is transformed into:

$$R' = \sum_{i=1}^{n} (p_i - c_i) x_i - \sum_{j=1}^{k} q_j \sum_{i=1}^{n} M_{ij} x_i - \sum_{j=k+1}^{m} q_j \sum_{i=1}^{n} M_{ij} x_i - \sum_{j=m+1}^{r} q_j \sum_{i=1}^{n} M_{ij} x_i \tag{5}$$

During the process of developing programs at this college, some of the information service capacity was able to meet the needs of developing programs and some was not. As a result, there was variability in the information costs of the program. To wit:

$$c_i = \sum_{j=1}^{r} M_{ij} e_j \tag{6}$$

Based on the above discussion of the parameters and objectives, the optimization model of the faculty information resources of the university is:

$$\begin{cases} MaxR' = \sum_{i=1}^{n} \left(p_i - c_i - \sum_{j=1}^{k} q_j M_{ij} - \sum_{j=k+1}^{m} q_j M_{ij} - \sum_{j=m+1}^{r} q_j M_{ij} \right) x_i \\ s.t. \sum_{i=1}^{n} M_{ij} x_i \le b_j, j = 1,2,3,\cdots,k \\ \sum_{i=1}^{n} M_{ij} x_i = b_j + s_j, j = k+1, k+2, \cdots, m \\ \sum_{i=1}^{n} M_{ij} x_i = s_j, j = m+1, m+2, \cdots, r \\ x_i \ge 0, i = 1,2,3,\cdots,n \end{cases} \tag{7}$$

Since the information service capacity $b_{k+1}, b_{k+2}, \cdots b_m, b_{m+1}, \cdots, b_r$ cannot satisfy the requirements of the program, it is necessary to rent from other information service enterprises. At the same time, there is a surplus of information service capacity $b_1, b_2, \cdots, b_k$, so c_i, which generates changes in program information costs due to changes in information service capacity b_j, is the covariate to be used for decision-making.

The optimal solution of this information resource optimization model represents the maximization of the university's revenue, and the results can be obtained by using the linear programming algorithm. Through the use of this model, universities can make the decision of renting in and renting out information service capacity, make reasonable arrangements for the allocation of information resources to meet the needs of teachers and students while maximizing the university's revenue.

For equation (7), it is from the perspective of meeting the needs of teachers and students, taking into account the maximization of information service revenue, but the information resource optimization model constructed by linear programming can only be configured under the condition of rigidity of the existing resource constraints, and it is difficult to achieve a balance between meeting the needs of teachers and students and maximizing the revenue of universities. In order to maximize the demand for customized services to meet the needs of students and faculty, universities need to consider the resource interaction in the resource constraints for the elastic resource optimization model, which can be adjusted according to the needs of students and faculty in a timely manner to their own information service capabilities. Through the reasonable deployment of information service capacity, it can maximally meet the customized needs of teachers and students, and at the same time enhance the rapid response capability to maximize the revenue.

III. B. 2) Pairwise modeling

Dyadic planning means that the same problem can be formulated from two opposite perspectives by approaching it from different angles [20], [21]. Thus, the original linear programming model (3) of dyadic modeling:

$$(DP)\begin{cases} \min g(y) = yb \\ s.t. yA \ge p - c \\ y \ge 0 \end{cases} \tag{8}$$

where $y = (y_1, y_2, \cdots, y_m)$ is the dyadic variable. The original linear programming problem and its dyadic problem are mutually exclusive. The dyadic problem has some economic significance: in the original problem, if the number of resources is used as a constraint to maximize the return from resource allocation. Then in the dyadic problem, the constraint is the constraint that is greater than or equal to the gain, so that the loss of resource allocation is minimized.

As a result, combining the transaction of information service companies, let be the shadow price of information service capacity, then the dyadic planning model of model (7) is:

$$\begin{cases} MinC = \sum_{j=1}^{k} b_j y_j + \sum_{j=k+1}^{m} (b_j + s_j) y_j + \sum_{j=m+1}^{r} s_j y_j \\ s.t. \sum_{j=1}^{r} M_{ij} y_j \geq p_i - c_i - \sum_{j=1}^{r} q_j M_{ij} \\ y_j \geq 0, j = 1, 2, \cdots, r \end{cases} \quad (9)$$

IV. Analysis of resourcing effects

IV. A. Performance comparison

This subsection first evaluates the effectiveness of the performance of the proposed optimal configuration method. To solve this problem, the resource allocation optimization model based on linear programming and three other algorithms were evaluated: BCG, BCG-IO, and BCG-PC. The running time limit of the algorithm is set to 12,000 seconds. Table 1 shows the comparison results of instance classes under different event scales. Where, | S|is the number of events, and N.So and A.Time represent the number of instances that can solve the optimal solution within the time limit and the corresponding average computing time, respectively. "A.Gap (%)" indicates the difference between the average optimality of the upper and lower bounds of the instances that have not solved the optimal solution after the algorithm is terminated, "Ave/To" specifies the average or sum of the corresponding statistical items, and "OOM" indicates that the algorithm cannot find a feasible solution due to insufficient memory. Based on preliminary experimental tests, the parameter φ set to 0.01.

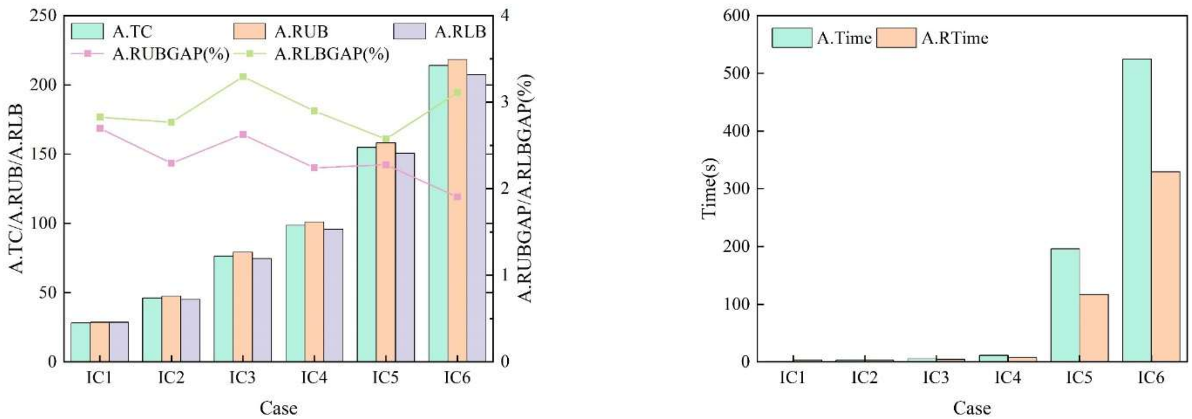
From Table 1, it can be seen that when |S| = 2, the average number of instances that can be solved to the optimal solution within the time constraints of the BCG, BCG-IO, BCG-PC and the optimal allocation model of this paper are 48, 48, 49, and 49, respectively. |S| = 4, the average number of instances that can be solved to the optimal solution of the BCG, BCG-IO, BCG-PC, and the method of this paper are all 45. |S| = 6, the average number of instances that can be solved to the optimal solution by BCG, BCG-IO, BCG-PC and the methods in this paper are all 49. The average computation time of the resource optimization allocation model based on linear programming in this paper is 28.44, 110.42, and 465.41 seconds when |S| takes the values of 2, 4, and 6. The average computation time of the BCG algorithm is 82.57, 375.36, and 1123.74 s. The average computation time of BCG-IO algorithm is 52.56, 292.83, and 919.91 s. The average computation time of BCG-PC algorithm is 52.98, 256.76, and 836.60 s, respectively. The difference between the method of this paper and the other methods is not much, but the difference in the average computation time is large, and the average computation time is much faster than the other algorithms. The results in Table 1 clearly demonstrate that the proposed method in this paper significantly reduces the solution time and improves the performance performance of the algorithm.

This section uses the number of events| S|=4 to test the quality level of the relaxation and sensitivity bounds. Firstly, the quality of the relaxation boundary is analyzed through the changes of some key indicators under different case categories. The results of the comparison are shown in Figure 1, which shows the average total cost of "A.TC", the average relaxation upper bound "A.RUB", the average relaxation lower bound "A.RLB", the average optimality gap of the relaxation upper bound "A.RUBGap (%)", the difference between the optimal values of the relaxation lower bound "A.RLBGap (%)", and the average computation time "A.Time" (accordingly, "A.RTime") on the instances in each instance class.

The results in Figure 1 show that, as expected, both the average total cost and the average slack lower and upper bounds increase as the problem size increases, and their values remain close to each other across all six case classes. It is worth noting that the average optimality gaps for the lower and upper bounds of slack fall in the range of [2.38%, 3.29%] and [1.89%, 2.72%], respectively. Fig. 1(b) illustrates that in terms of the solution time, for the instances in the first four case classes, the average computation time of this paper's method is very close to the average computation time of solving TADRM-HE, while for the last two case classes, the method reduces the computation time on average by as much as 41.25% and 38.26%, respectively, compared to TADRM-HE. The results in Fig. 1 illustrate that the obtained relaxation bounds are very tight (the optimality gap is very small), especially for large-scale problems, and that the relaxation upper bounds can be used to obtain resource allocation solutions with less computational time.

Table 1: Algorithm performance comparison results

Instance size		BCG			BCG-IO		
|S|	IC	A.Time	A.Gap (%)	N.So	A.Time	A.Gap (%)	N.So
2	IC1	0.54	0	8	0.46	0	8
	IC2	0.72	0	8	0.53	0	8
	IC3	1.65	0	8	1.25	0	8
	IC4	6.75	0	8	5.02	0	8
	IC5	148.96	0	8	87.65	0	8
	IC6	336.78	0	8	220.43	0	8
	Ave/To	82.57	0	48	52.56	0	48
4	IC1	0.79	0	8	0.58	0	8
	IC2	1.25	0	8	0.94	0	8
	IC3	7.98	0	8	6.78	0	8
	IC4	25.23	0	8	19.56	0	8
	IC5	421.26	0	8	372.65	0	8
	IC6	1795.64	OMM	5	1356.48	OMM	5
	Ave/To	375.36	OMM	45	292.83	OMM	45
6	IC1	1.56	0	8	0.98	0	8
	IC2	7.05	0	8	5.86	0	8
	IC3	35.48	0	8	26.89	0	8
	IC4	53.76	0	8	38.47	0	8
	IC5	970.28	OMM	5	788.64	OMM	5
	IC6	5674.32	OMM	4	4658.63	OMM	4
	Ave/To	1123.74	OMM	49	919.91	OMM	49
Instance size		BCG-PC			Ours		
|S|	IC	A.Time	A.Gap (%)	N.So	A.Time	A.Gap (%)	N.So
2	IC1	0.42	0	8	0.26	0	8
	IC2	0.48	0	8	0.34	0	8
	IC3	1.23	0	8	0.82	0	8
	IC4	4.99	0	8	2.17	0	8
	IC5	86.23	0	8	36.52	0	8
	IC6	224.53	0	8	130.54	0	8
	Ave/To	52.98	0	48	28.44	0	48
4	IC1	0.53	0	8	0.43	0	8
	IC2	0.92	0	8	0.58	0	8
	IC3	5.62	0	8	3.67	0	8
	IC4	15.75	0	8	7.59	0	8
	IC5	283.24	0	8	135.64	0	8
	IC6	1234.52	OMM	5	514.63	OMM	5
	Ave/To	256.76	OMM	45	110.42	OMM	45
6	IC1	0.86	0	8	0.54	0	8
	IC2	5.23	0	8	2.28	0	8
	IC3	20.32	0	8	5.88	0	8
	IC4	27.96	0	8	20.62	0	8
	IC5	715.63	OMM	5	534.74	OMM	5
	IC6	3962.45	OMM	4	1748.76	OMM	4
	Ave/To	836.60	OMM	49	465.41	OMM	49



(a) The quality of the relaxation boundary (b) Calculation time

Figure 1: Performance of the slack in different cases

IV. B. Results of small-scale problem experiments

According to the parameter combinations, there are 2×2×4×3=48 parameter combinations in the small-scale problem, and each parameter combination generates 10 algorithms, so there are 480 algorithms in total. There are 2×2×4×3×2=96 parameter combinations for the large-scale problem, and each parameter combination generates 10 algorithms, so there are 960 algorithms in total. A total of 1440 algorithms are studied in this paper for the combined large and small scale problems. In this section, the solution quality of 480 small-scale cases using the established mixed-integer linear programming model mentioned above, the improved NCIAIS algorithm based on complete immunoglobulin, the original C-IAIS algorithm based on immunoglobulin, and the SA algorithm based on hybrid simulated annealing will be comparatively analyzed and the performance of each algorithm will be evaluated, and the performance of each algorithm will be evaluated for 960 cases. The performance of each algorithm is evaluated, and 960 large-scale cases are experimented with the four algorithms. In the analysis and comparison of the experimental results, the algorithms are evaluated by the relative deviation index (RDI).

The results of the average RDI values of 10 algorithms for each combination of algorithm parameters computed under the small-scale experimental problem are shown in Table 2, where T is the planning multiplier and n is the number of cases. In Table 2, it can be comprehensively observed that the mean RDI values of this paper's model, NCIAIS, C-IAIS, and SA algorithms are 13.38, 18.00, 18.03, and 15.89, respectively, when the number of cases is 5. When the number of cases is 10, the mean RDI values of this paper's model, NCIAIS, C-IAIS, and SA algorithms are 12.77, 16.98, respectively, 18.80, 16.77.The linear programming based resource allocation model in this paper has the least deviation and the best results.

Table 2: The average RDI value of all methods under small-scale issues

n	T	Ours	NCIAIS	C-IAIS	SA
5	2	15.02	16.02	26.78	18.05
	3	9.26	9.95	10.83	9.85
	4	15.86	28.02	16.47	19.77
	Average	13.38	18.00	18.03	15.89
10	2	15.42	19.91	22.01	16.15
	3	8.74	15.59	18.07	11.08
	4	14.16	15.44	16.32	23.09
	Average	12.77	16.98	18.80	16.77

IV. C. Results of experiments on large-scale problems

During the experiment, each of the four algorithms was repeated 10 times for each experimental example problem, and the average of the 10 results was obtained as the result of this algorithm for solving this experimental problem. There are 10 examples of each type of experimental problem, and the results of their solution quality are evaluated by the relative deviation index (RDI). The results of the average RDI values of the 10 algorithms calculated for each combination of algorithm parameters under the large-scale experimental problem are shown in Table 3.

From the data in Table 3, it can be seen that the average RDI values of this paper's model are 13.70 and 15.06 when the number of cases is 100 and 200, respectively, which are lower than the average RDI values of the NCIAIS, C-IAIS, and SA algorithms, which shows that this paper's resource optimization and allocation model based on linear programming has the best solving effect.

Table 3: The average RDI value of all methods under large-scale issues

n	T	Ours	NCIAIS	C-IAIS	SA
100	2	13.55	31.23	50.87	21.92
	3	13.13	34.62	50.61	23.07
	4	14.43	30.25	51.78	20.11
	Average	13.70	32.03	51.09	21.70
200	2	15.07	32.08	52.07	23.87
	3	14.44	32.87	51.15	22.63
	4	15.67	34.88	51.74	22.38
	Average	15.06	33.28	51.65	22.96

V. Conclusion

In order to realize the informationization of school affairs as well as the optimal allocation of school affairs information resources, this paper puts forward the relevant problems after fully analyzing the defects on the current school affairs information service. It tries to carry out linear planning for school affairs information, so as to improve the resource allocation effect of school affairs information.

The average number of arithmetic cases in solving the optimal solution of the resource optimization allocation model in this paper is not much different from that of other algorithms, but the computation time consumed is significantly shorter than that of other algorithms. The average computation time of this paper's resource optimization allocation model based on linear programming is 28.44, 110.42, and 465.41 seconds for $|S|=2$, 4, and 6, respectively. In the small-scale problem experiments, the mean RDI values of this paper's model on the number of cases of 5 and 10 are 13.38 and 12.77, respectively. In the large-scale problem experiments, the mean RDI values of this paper's model on the number of cases of 100 and 200 are 13.70 and 15.06, respectively. The RDI values of this paper's model are much lower than those of other algorithms, which have a smaller deviation and better results.

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