J. COMBIN. MATH. COMBIN. COMPUT. 127b (2025) 6003--6018

Journal of Combinatorial Mathematics and Combinatorial Computing
www.combinatorialpress.com/jcmcc

# Co-optimization Research on Digitalization of Enterprise Human Resource Management and Integrated Construction of Measurement and Training Based on Optimization Algorithm

Man Liu[1], Shichen Yu[1,✉]

[1] *Business School, City University of Zhengzhou, Zhengzhou, Henan, 450000, China*

ABSTRACT

In this paper, we construct a multi-level network based on corporate mobility relationships to quantify human resource attributes. The cuckoo search algorithm (CS) is chosen to enhance the global optimization capability of human resource management scheme. Combine CS and XGBoost to construct CS-XGBoost algorithm, and realize the optimal solution of HRM scheme through hyperparameter optimization and other steps. The multi-project human resource management of construction enterprises is taken as an example to verify the auxiliary value of CS-XGBoost algorithm in the generation of optimal management scheduling scheme. Empirical studies show that the algorithm can obtain the optimal solution in about 450 iterations. In multi-project scheduling management, the optimal duration can be reduced to 510 days, which is better than the comparison algorithm. With the introduction of demand prioritization requirements, the algorithm can effectively balance the differences in project duration, project cost and employee working time. The CS-XGBoost algorithm can be used to quickly realize the optimal decision-making of enterprise human resource scheduling management, save costs and improve efficiency.

*Keywords:* human resource management; multilevel dynamic network; cuckoo search algorithm; XGBoost integrated learning; hyperparameter optimization

## 1. Introduction

With the continuous development of science and technology, digital transformation has become a key task in the transformation and upgrading of modern enterprises. As the asset with the most potential and core competitiveness of an enterprise, human resource management also needs to be similarly digitally transformed to adapt to the rapidly changing business environment [1]. The digitalization of

✉ Corresponding author.
*E-mail address:* 18538260243@163.com (S. Yu).

Received 15 January 2024; Revised 10 February 2024; Accepted 30 November 2024; Published Online 16 April 2025.
DOI: 10.61091/jcmcc127b-329

HRM can provide automated workflows and intelligent data management systems, which greatly improve work efficiency; it can eliminate information silos and promote teamwork and knowledge sharing through a variety of communication and collaboration tools; it can collect and analyze a large amount of data and provide more accurate and comprehensive information support, which can better guide decision-making and implementation; and it can provide a better employee experience , such as online training, self-service, and personalized benefits management, which can help improve employee satisfaction and loyalty [2-5]. However, there are also some challenges and risks for HRM in enterprises in digital transformation. The traditional e-HRMS used by enterprises often need to be parallel with other management systems, but their compatibility is poor and the cost and technical requirements are high; inconsistent data standards and imperfect sharing mechanisms between different departments lead to data silos; and some of the basic transactions are cumbersome and decision-making support is insufficient [6-9]. In addition, organizations need to address the issues of information security and privacy protection to avoid leakage and misuse of employees' personal information [10]. In digital transformation, it needs to be more efficient, lean, and smart, and the quality and skills of employees are required to be higher, while the existing employees have the problem of insufficient quality adaptation to the new digital management and technology, which needs to be solved to face the resistance of employees to digital transformation and the need for training [11-13]. Therefore, there is a need for employee assessment and training to better realize the digitalization of enterprise human resource management.

Talent assessment is part of the overall solution of human resource management, is an inseparable part of human resource development, which is closely related to job analysis, selection, assessment, training, personnel incentives, etc., especially in the selection of a high value of use [14-15]. It can be said that the depth and scope of application of talent assessment is constantly expanding. Talent assessment was initially intended for recruitment and selection applications, and then gradually developed to be used for management potential confirmation and training, promotion, personal future development, career management and other aspects [16-17]. However, most of the current enterprise assessment of employees is only to obtain the employee's performance, mindset changes, job fitness, the results of its role in the training program in only a few companies [18]. It can be seen that the implementation of enterprise human resource management digitalization and employee assessment and training is seriously fragmented.

Problems such as resource competition and task dependence require enterprises to choose better algorithms for human resource assistance management. In this paper, by constructing a multi-level network based on the relationship between personnel flow, resource constraints, etc., we provide a data base for subsequent algorithm applications. Cuckoo search algorithm (CS) is introduced to avoid the defect of falling into local optimum through Levy flight mechanism and dynamic elimination strategy. Design the XGBoost integrated learning framework based on CS optimization to improve the computational accuracy of the scheduling scheme through feature selection and hyper-parameter co-optimization. The CS-XGBoost algorithm is applied to the multi-project human resource management scheduling of real enterprises to efficiently generate the management scheduling scheme, which can assist enterprises to achieve the balance between project efficiency and resource utilization. Based on the actual research effect, the integrated construction program of human resource management and measurement and training is designed to support the enterprise management through methodology.

## 2. Research methodology and modeling

This chapter constructs a multilevel dynamic network based on the type of personnel movement and so on. The cuckoo search algorithm (CS) is introduced to enhance the global optimization search capability through levy flight mechanism and so on. Further, the XGBoost model based on CS optimization is designed to find the global optimal solution through feature selection and hyperparameter co-optimization.

### 2.1. Mobility multilevel networking

Human resource planning in multilevel organizations is usually carried out by controlling the movement of people within and outside the organization or between units or positions at different levels within the organization. Therefore, this section constructs a multilevel network for personnel mobility in a multilevel organization. Figure 1 shows a specific staff mobility multilevel network structure.

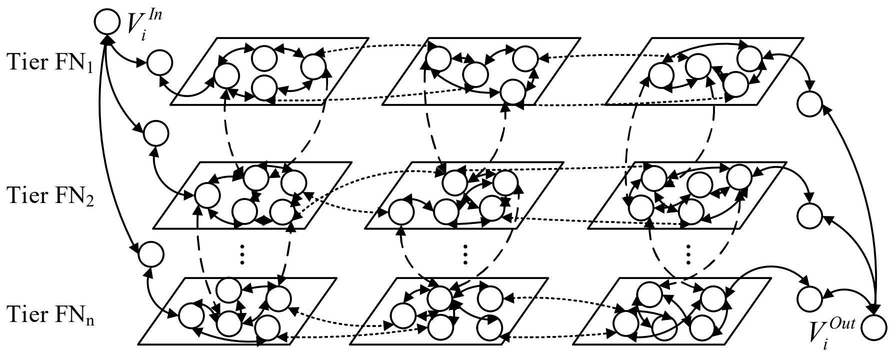


**Fig. 1.** Multi-level network structure of personnel flow

This flow network (FN) contains multiple layers and the structure can be generalized and represented by equation (1).

$$FN = \{FN_1, FN_2, \dots, FN_i, \dots, FN_n\} \tag{1}$$

Each mobility network in Hierarchy $i$ can be viewed as a collection of nodes and edges as shown in equation (2). In the multi-tier network of staff mobility in Figure 1, each tier contains two special nodes, $V_i^{In}$ and $V_i^{out}$, which represent the staff mobility between units in each tier and the outside of the organization. The other nodes represent units or positions contained in level $i$ within the organization, and the edges between the nodes represent the existence of staff mobility between units or positions.

$$FN_i = (V_i, E_i) \tag{2}$$

Depending on the organizational context, each node may contain a number of attributes, such as the name of the unit or position to which the node corresponds, its priority, the current amount of personnel it contains, etc. Similarly, each edge can have several attributes, such as the start and end points of the flow, the type of flow, the amount of personnel flow, etc., all of which need to be considered according to the specific problem context.

### 2.2. Cuckoo Search Algorithm

Cuckoo search algorithm (Cs), also called cuckoo search, is an emergent heuristic algorithm. The CS algorithm is an algorithm that efficiently solves optimization problems by simulating parasitic broods of certain species of cuckoos. Also, the CS algorithm employs the related Levy flight search mechanism.

In nature, cuckoos search for suitable nest locations for their egg-laying in a randomized or random-like manner. To simulate the cuckoo's nest search, the following three ideal rules are assumed:

1) Cuckoos randomly choose a nest host to incubate their eggs and lay only one egg at a time;

2) The best nest will be kept for the next generation;

3) The number of available nests $n$ is fixed and the probability that a nest host will find an exotic egg is $P_a \in [0,1]$.

Based on these three ideal rules, the updated formula for the cuckoo's path and location to find a nest is as follows:

$$x_i^{(t+1)} = x_i^{(t)} + \alpha \oplus Levy(\lambda) i = 1, 2, \cdots, n \tag{3}$$

Where: $x_i^{(t)}$ denotes the nest position of the $i$ nd nest in the $t$ rd generation; $\oplus$ is the point-to-point multiplication; $\alpha(\alpha > 0)$ is the step control quantity, which is generally taken as $\alpha = 2$; and $Levy(\lambda)$ denotes the Levy search path, with a randomized step that satisfies the Levy distribution:

$$Levy(s, \lambda) \sim s^{-\lambda}, 2 < \lambda \leq 4 \tag{4}$$

Here $s$ represents the randomized step obtained from Levi's flight. After updating through the positions, a random number $r \in [0,1]$ is used to compare with $P_a$. If $r > P_a$, the positions $x_i^{(t+1)}$ of the bird nests are randomly changed, and vice versa unchanged. Finally the set of bird nest locations with better fitness values are retained.

### *2.3. CS-based XGBoost Training Methods*

Based on the advantageous characteristics of CS and the defects of XGBoost without parameter optimization, a CS-based XGBoost training method is proposed to improve the classification accuracy of the base classifier XGBoost. A hybrid model, i.e., CS-XGBoost, is constructed by using CS to adjust the eight hyperparameters that have a large influence in the training process of XGBoost.Fig. 2 shows the basic flow of CS-XGBoost, and its detailed execution steps are as follows:

Step1: Data preprocessing. In order to build the classification model XGBoost, the dataset needs to be divided into training set and test set.

Step2: Setting XGBoost parameters. Set the parameters other than the 8 hyperparameters to be optimized by XGBoost, and select the default parameter settings.

Step3: Initialize CS. set the bird's nest population size $n$, the discovery probability $P_a$ (in general, $P_a = 0.25$), the search space boundary value ($S$, see Eq. (7)), and the maximum number of iterations M. The iterative optimization procedure based on XGBoost specifies the bird's nest population as the search agent to run the model, and the position of the bird's nest population and the corresponding fitness matrix are represented as follows:

$$Nest = \begin{bmatrix} x_{1,1}^{eta}, x_{1,2}^{n\_estimators}, \cdots, x_{1,9}^{reg\_lambda} \\ x_{2,1}^{eta}, x_{2,2}^{n\_estimators}, \cdots, x_{2,9}^{reg\_lambda} \\ \cdots\cdots \\ x_{n,1}^{eta}, x_{n,2}^{n\_estimators}, \cdots, x_{n,9}^{reg\_lambda} \end{bmatrix} \tag{5}$$

$$NF = \begin{bmatrix} f_1 \\ f_2 \\ \cdots \\ f_n \end{bmatrix} \tag{6}$$

where $n$ denotes the population size of the bird nests, with a total of 8 dimensions for each individual bird nest, corresponding to the XGBoost hyperparameters in order from the first to the eighth dimension. $x_{i,j}$ denotes the $j$ th dimension in the $i$ rd bird nest, and $f_i$ denotes the adaptation value corresponding to the $i$ th bird nest.

Step4: Randomly initialize bird nest locations. Individuals in the cyclic bird nest population are used to compute random initial values for each dimension of the bird nest from expression (8) within the search space (see Eq. (7)).

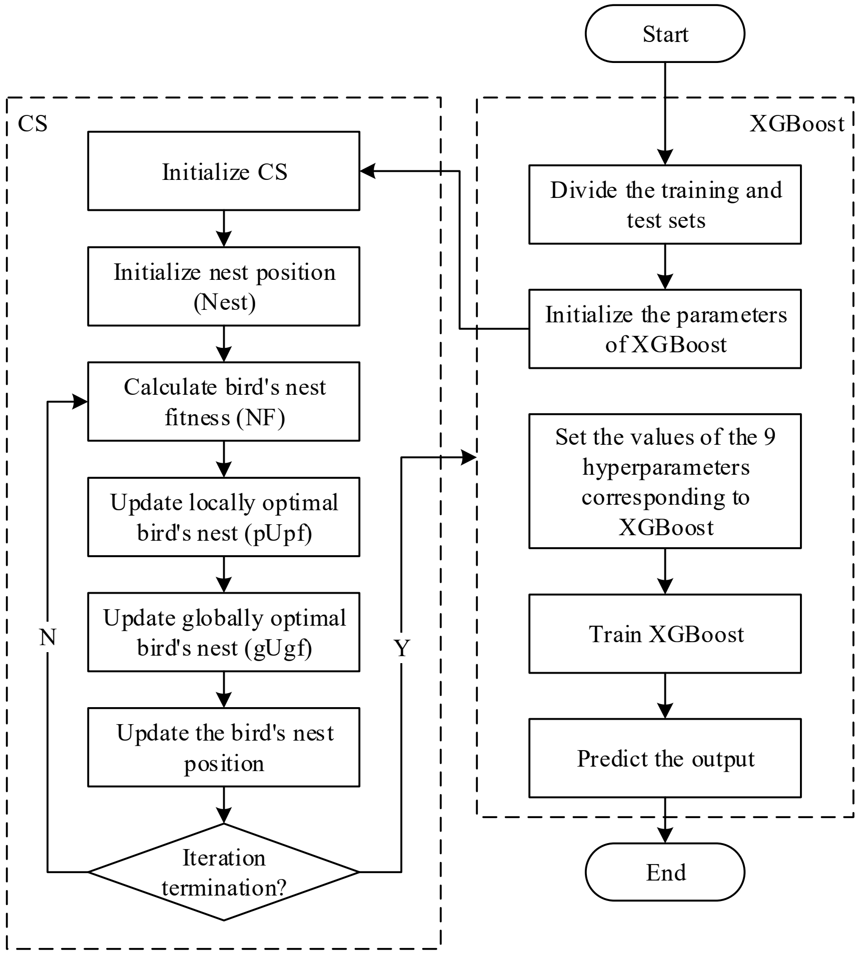


**Fig. 2.** The basic flow of CS-XGBoost

$$S=[lb,ub] \tag{7}$$

where $S$ denotes an 8*2 dimensional matrix, $lb=[0.01,10,1,0.01,0.01,0.01,0.01,0.01]^T$ denotes the lower bound of the search for the 8 parameters of XGBoost, and $ub=[0.3,1000,15,10.0,1.0,1.0,1.0,1.0]^T$ denotes the upper bound of the search for the 8 parameters of XGBoost, where $ub_j$ and $lb_j$ denote the upper and lower bounds of the search for the $j$ th hyperparameter variable to be optimized, respectively.

$$x_{\cdot,j}=random\left(lb_j,ub_j\right) \tag{8}$$

Where $random(\ )$ denotes a random function which returns a random number in the interval $\left[lb_j,ub_j\right]$.

Step5: Calculate the bird's nest adaptation. The classification accuracy of XGBoost is set as the adaptation function. The specific calculation process: firstly, the 8 hyperparameter values corresponding to XGBoost are set as the bird's nest location variable values, secondly, the dataset is input to train and test the model, and then the classification accuracy is calculated, and the output accuracy score is the bird's nest adaptation value.

Step6: Update the local optimal bird's nest. The current is the $t$ rd iteration, compare the adaptation value of the $t$ th generation bird nest, and update the current local optimal bird nest $p^{(t)}$ with the largest adaptation value (assumed to be the $v$ th bird nest), denoted as: $p^{(t)}=\left[x_{v,1}^{eta},x_{v,2}^{n\_estimators},\cdots,x_{v,9}^{reg\_lambda}\right]$.

Step7: Update the global optimal bird's nest. Compare the fitness of contemporary locally optimal bird's nest $p^{(t)}$ and $t-1$nd generation globally optimal bird's nest $g_{t-1}$, and select the bird's nest with greater fitness to be updated as globally optimal bird's nest $g^{(t)}$, denoted as $g^{(t)} = \left[ x_{v,1}^{eta}, x_{v,2}^{n\_estimators}, \cdots, x_{v,9}^{reg\_lambda} \right]$.

Step8: Update the bird's nest position. This step is the core step of the proposed method, which consists of two operations:

Step9: The random wandering of Levi's flight is used to update the bird's nest location. The expression (9) goes to update the bird nest positions of the current $t$th iteration to obtain a new set of bird nest positions, comparing the old and new bird nest fitness values and retaining the bird nest position with greater fitness.

$$x_{i,j}^{(t)} = x_{i,j}^{(t-1)} + \alpha \otimes Levy(\beta) \tag{9}$$

where $x_{i,j}^{(t)}$ denotes the value of the $j$rd dimension of the $i$nd nest on the $t$th iteration, $x_{i,j}^{(t-1)}$ denotes the value of the $j$th dimension of the $i$th nest on the $t-1$th iteration, $\alpha > 0$ denotes the step control variable (usually taken as $\alpha = O(L/10)$, where $L$ denotes the feature dimension), $\otimes$ denotes the dot product, and $Levy(\beta)$ is the Lévy stochastic path, which has the following mathematical expression:

$$Levy(\beta) = \frac{u}{|v|^{\frac{1}{\beta}}} \tag{10}$$

where $u$ is a random number obeying $N(0, \sigma^2)$, $v$ is a random number obeying $N(0,1)$, and $\sigma = \left\{ \frac{\Gamma(1+\beta)\sin\left(\frac{\pi\beta}{2}\right)}{\beta\Gamma\left(\frac{1+\beta}{2}\right)2^{\frac{\beta-1}{2}}} \right\}^{\frac{1}{\beta}}$, usually $\beta = 2$.

$$x_{i,j}^{(t)} = x_{i,j}^{(t-1)} + \gamma \otimes H(p_a - \varepsilon) \otimes \left( x_{i,j}^{(t-1)} - x_{k,j}^{(t-1)} \right) \tag{11}$$

where $x_{i,j}^{(t)}$ and $x_{i,j}^{(t-1)}$ denote the values of the $j$th dimension of the $i$rd bird's nest on the $t$th and $t-1$th iterations, respectively, $x_{i,j}^{(t-1)}$ and $x_{k,j}^{(t-1)}$ denote the two different solutions randomly chosen in the $t-1$th iteration, $H(\mu)$ is the Hoviside function (step function, see Eq. (12)), $P_a$ is the switching parameter used to balance the local and global random wandering, $\gamma, \varepsilon$ is the random number obeying a uniform distribution, and $\otimes$ denotes the dot product of the two vectors.

$$H(\mu) = \begin{cases} 0, & \mu < 0 \\ \frac{1}{2}, & \mu = 0 \\ 1, & \mu > 0 \end{cases} \tag{12}$$

Step10: Judge whether the current iteration has reached the iteration termination condition. If the current iteration number does not reach the maximum iteration number $(M)$, return to Step5 to continue the iteration loop; otherwise, output the global optimal bird's nest position (i.e., XGBoost corresponds to the value of the 8 combined parameters) and end all operations.

## 3. Multi-project human resources management scheduling empirical study

In this chapter, the optimized CS-XGBoost algorithm is applied to multi-project human resource management scheduling in construction enterprises to verify the practical value of CS-XGBoost algorithm in assisting enterprises in human resource management.

### *3.1. Analysis of the resource situation and comparison of the total construction period*

Taking the optimization of human resource management in construction enterprises as an example, an empirical study of multi-project human resource management scheduling is carried out. Three real construction engineering construction projects with different priorities share 11 kinds of key resources (R1, R2, R3,......,R11), and Table 1 is the supply of shared resources of the three projects. In Table 1, column 1 is the resource number, column 2 is the corresponding resource description, and column 3 is the amount of resources available per day. Analyzing Table 1, it can be found that the 2 types of available human resources, crane workers and excavator workers, are the most scarce, probably because these 2 types of workers are needed in every project and the learning cost of these 2 types of work is relatively high, so the amount of human resources available for dispatching is relatively small. This also requires enterprises to make more rational planning in the scheduling and management of these two types of human resources. Available human resources are relatively more carpenters, general workers and painters, in the resource scheduling management can be appropriate scheduling management efforts to other human resources tilt.

**Table 1.** The shared resource availability of three projects

| Resource ID | Resource description | Available units per day |
|---|---|---|
| $R_1$ | Carpenter | 8 |
| $R_2$ | General worker | 9 |
| $R_3$ | Lifting man | 2 |
| $R_4$ | Mechanical and electrical engineer | 5 |
| $R_5$ | Digger | 2 |
| $R_6$ | Painter | 8 |
| $R_7$ | Bar worker | 7 |
| $R_8$ | Concreter | 6 |
| $R_9$ | Plumber | 5 |
| $R_{10}$ | Other skilled workers | 3 |
| $R_{11}$ | Tiler | 7 |

The improved CS-XGBoost algorithm in this paper is utilized to manage the scheduling of human resources for three projects, while comparing the optimal scheduling duration results with the other five algorithms. Table 2 shows the comparison of the optimal duration scheduling solution results of the 6 algorithms. As seen in Table 2, for the three real projects, the CS-XGBoost algorithm generates better optimal experimental results than all the other algorithms, with a minimum duration of 510 days, which is 10 days less than the 520 days obtained by the hybrid genetic-simulated depopulation algorithm, and more than 30 days less than the other algorithms. The experimental data shows that the CS-XGBoost algorithm performs very well in solving this type of problem and shows its superiority in solving complex and large multi-project human resource scheduling problems.

**Table 2.** Results comparison of each algorithm

| Scheduling algorithm | Best Results (days) | Average results of the 10 best trials (days) |
|---|---|---|
| Genetic algorithm | 544 | 545.2 |
| Simulation ham algorithm | 548 | 549.1 |
| Hybrid algorithm of genetic and simulated ham | 520 | 534.2 |
| Improved simulated ham Algorithm (arithmetic method) | 543 | 546.0 |
| Improved simulated ham Algorithm (logarithmic method) | 541 | 553.7 |
| CS-XGBoost algorithm | 510 | 529.4 |

For the algorithms such as Genetic Algorithm (GA), Simulated Depopulation (SA) algorithm, and Modified Simulated Depopulation (MSA), the final experimental results of the algorithms are not changed after increasing the number of iterations beyond 15000. This proves that the optimal solution obtained by the hybrid genetic algorithm-simulated depopulation algorithm is a global optimal solution. However, the CS-XGBoost algorithm obtains a better solution, which can be analyzed for two reasons: first, it is related to the limited global optimality finding ability of the algorithms such as GA, SA, and MSA; and second, it is related to the decoding or schedule generation mechanism, i.e., for a given task priority encoding, the schedule generation mechanism fails to find an optimal solution under that encoding scheme.

### 3.2. *Optimal Scheduling Solution Time and Resource Usage Study*

Figure 3 depicts the convergence graph of CS-XGBoost solving three real project scheduling problems with multiple project durations. The use of human resources in categories R1-R5 is visualized to analyze the use of each resource in the optimal scheduling results. Figure 4 shows the utilization of R1 resources in the optimal scheduling results. Figure 5 is the use of R2 resources in the optimal scheduling results. Figure 6 shows the utilization of R3 resources in the optimal scheduling result. Fig. 7 is the usage of R4 resource in the optimal scheduling result. Fig. 8 shows the usage of R5 resources in the optimal scheduling result. From Fig. 3, it can be seen that the CS-XGBoost algorithm computes the global optimal solution in about 450 iterations, which has faster computational efficiency and higher computational results compared to other algorithms after 15,000 iterations. Analyzing the use of human resources in the optimal scheduling results in Figure 4-Figure 8, it is found that all types of human resources are maximized and reasonably utilized, such as two cranes and two excavators in the work time schedule in line with the actual amount of human resources, there will not be a situation in which the amount of the task can not be completed by the overload or the work time is extended indefinitely. Using CS-XGBoost algorithm to manage scheduling of multi-project human resources can effectively improve the efficiency and level of enterprise management.

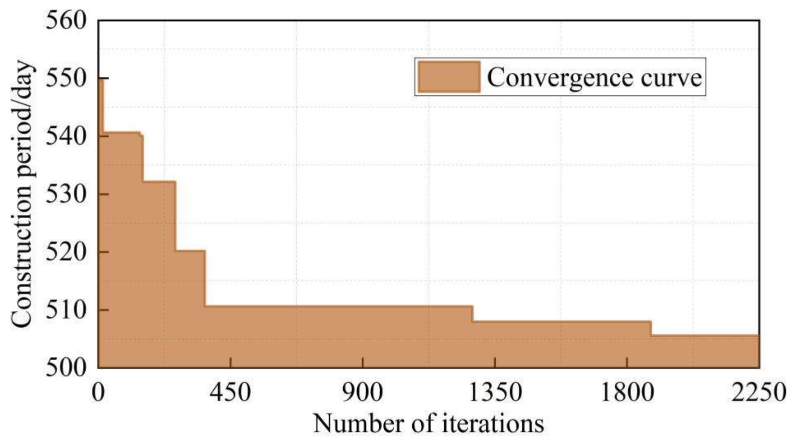


**Fig. 3.** Evolution curve of the multi-project makespan

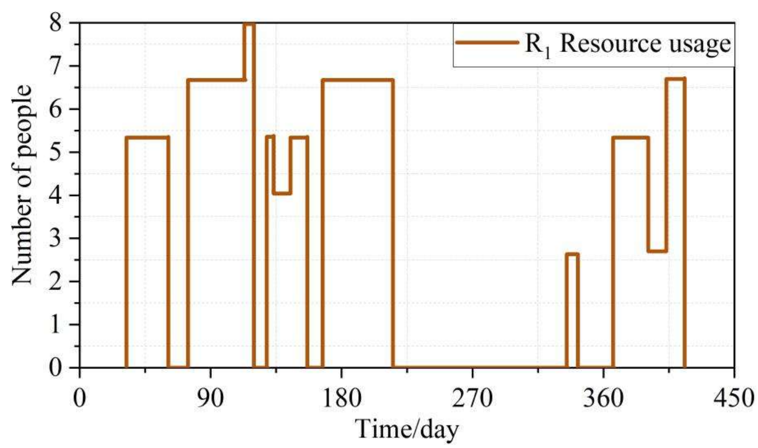


**Fig. 4.** The daily usage of R1

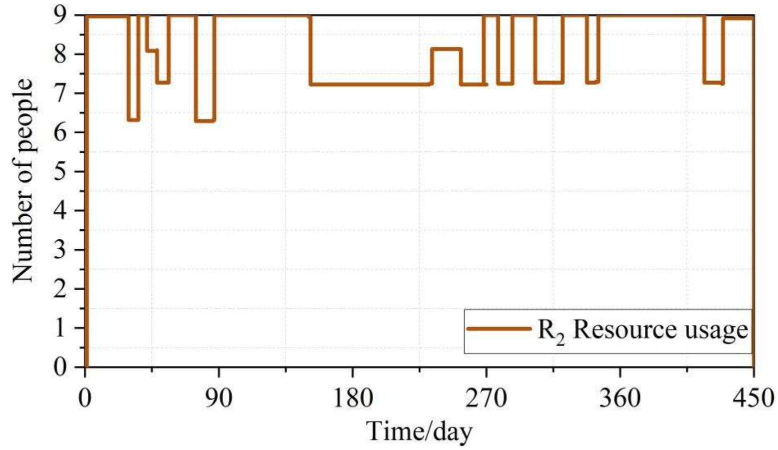


**Fig. 5.** The daily usage of R2

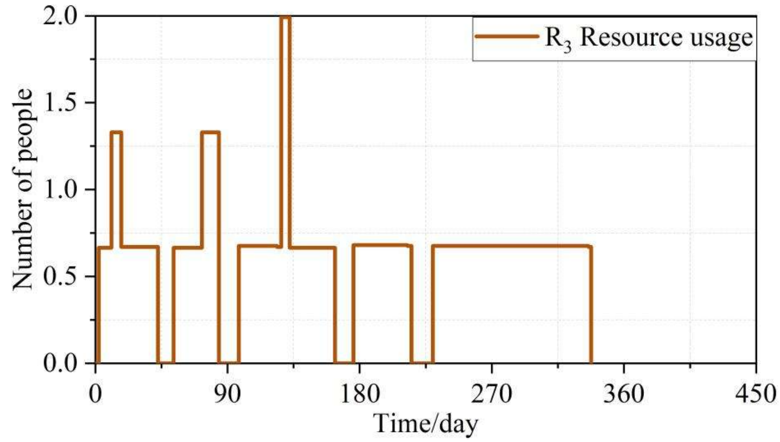


**Fig. 6.** The daily usage of R3

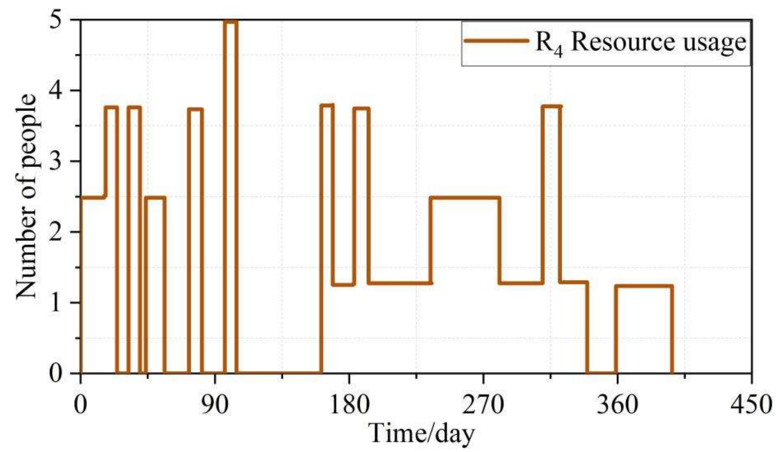


**Fig. 7.** The daily usage of $R_4$

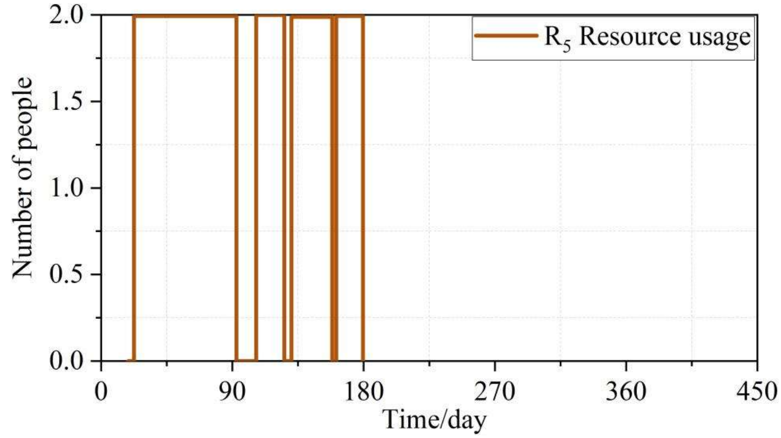


**Fig. 8.** The daily usage of $R_5$

### *3.3. Optimal Scheduling Solution after Introducing Demand Prioritization*

After solving the optimal scheduling time and resource allocation, we further introduce multiple requirement priority information in each project, and take the top 10 requirements in the priority ranking as the high-priority requirements, using CS-XGBoost algorithm with the population set to 250 and the iteration set to 450, and solving the optimal scheduling plan with the three objectives of integrated duration, staff work balance, and project cost. Figure 9 shows the Pareto frontier of CS-XGBoost algorithm based on project duration, project cost, and staff time balance as the objectives for three development projects of the construction company. It can be seen that there are constraints between multiple objectives, and it is not possible to obtain a solution that is optimal in all indicators, so corporate managers can choose quickly according to their project status, development of manpower and preferences, such as the project time is more intense, you can prioritize the project duration of a shorter program; or project time is more relaxed, prioritize the project cost of a lower program.

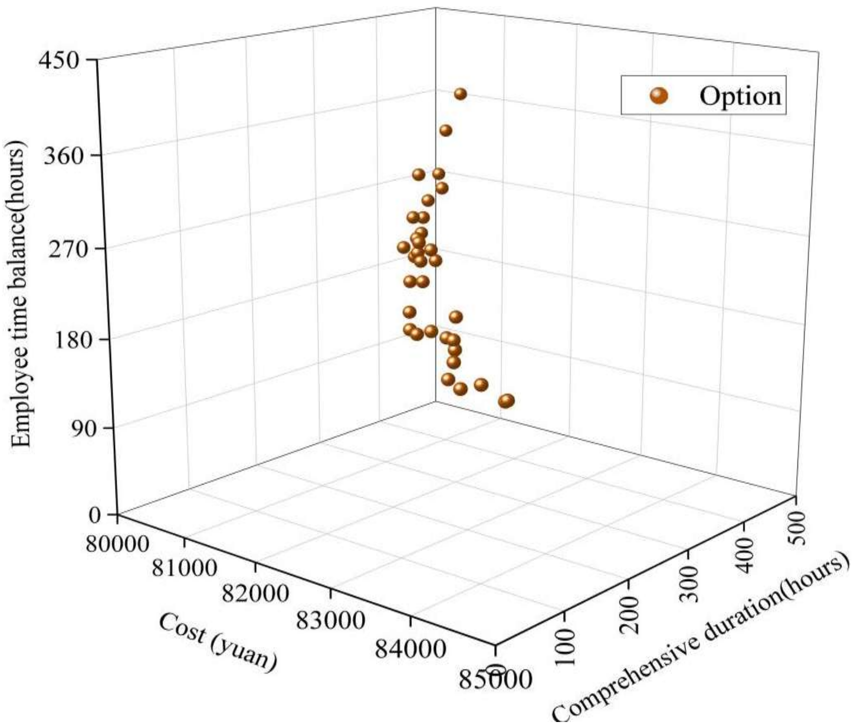


**Fig. 9.** Pareto frontier of non-dominated sorting genetic algorithm

Among the multiple scheduling schemes obtained from the computation, the project duration (high-priority duration) of the optimal scheme 1 is around 206 hours, the cost is around $82,691.60, and the staff time is balanced to be around 145 hours. For the optimal scheduling scheme given by CS-XGBoost algorithm is generally represented by a Gantt chart, and the corresponding project scheduling Gantt chart and manpower scheduling Gantt chart are given below for the optimal scheme 1 as a visual display of the scheme.

Figure 10 shows the task scheduling Gantt chart for optimal scheme 1. In the figure, the x-axis is the project man-hours, and the y-axis is the specific tasks of the 10 requirements, of which the end of FE indicates the front-end site development tasks, and the end of BE indicates the back-end material preparation tasks. In the case of requirement B1, for example, there is no immediately preceding requirement, and its earliest start time is the 9th hour, in which the back-end material preparation task starts at the 15th hour and lasts for 56 hours, the front-end site development task starts at the 9th hour and lasts for 51 hours, and the overall completion time of the requirement is the 71st hour. Of the high priority requirements, the latest requirement to be completed is D1, whose back-end tasks end at hour 206, resulting in a high priority duration of 206 hours.

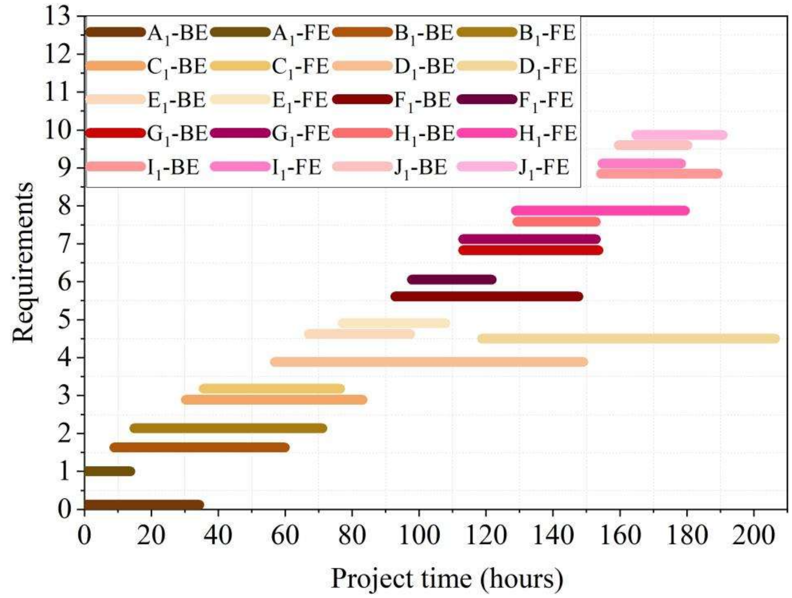


**Fig. 10.** Optimal scheme 1 Project scheduling Gantt chart

Figure 11 shows the staff scheduling Gantt chart for Optimal Option 1. Overall the back-end material preparation workload is greater than the front-end site development workload, the number of tasks assigned to general laborers and carpenters is higher, this is due to the fact that general laborers and carpenters are more important in the preparation of materials, and the number of people is relatively large, prioritizing the assignment of different task requirements to these two types of employees is conducive to shortening the duration of the work, at the same time, the difference in working hours between different personnel is small, and the maximum difference in working hours is not more than 24 hours.

Overall, the scheduling of the optimal plan 1 is more balanced, suitable for the case of tight schedule, and also can ensure that the high-priority tasks can be completed earlier, and the distribution of personnel work is more balanced.

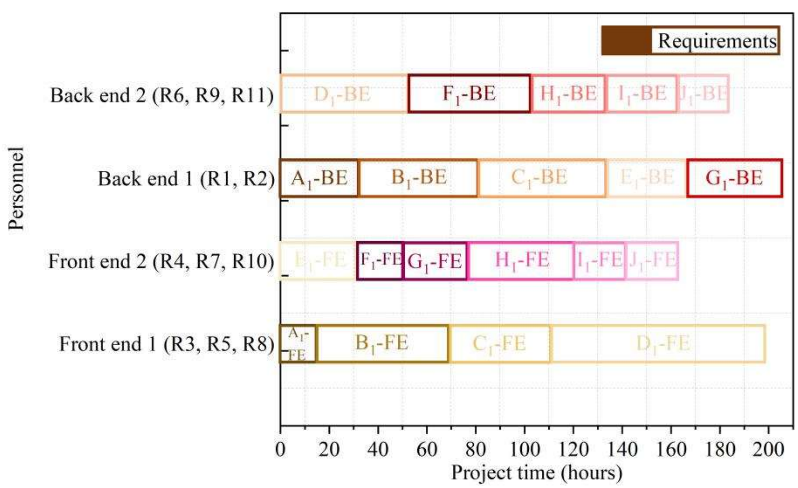


**Fig. 11.** Optimal scheme 1 Gantt chart for personnel scheduling

## 4. Integration of human resources management and assessment and training programs

Human resource management cannot be separated from effective scheduling and testing and evaluation programs. In view of the existing human resources of the enterprise, testing and training activities are carried out for the employees to improve the level of the employees in an all-round way. Taking the construction enterprises in this paper as an example, we should not only improve the working level of front-end site development staff and back-end material preparation technicians, but also focus on improving the decision-makers' ability to recognize the optimal solution calculated by the CS-XGBoost algorithm, and at the same time pay attention to the relevant emergency response ability of the safety management personnel at the construction site. Overall, it is necessary to start from various aspects to promote the synchronized development of human resource management and the integrated construction of measurement and training.

To promote the simultaneous development of human resources management and the integration of measurement and training, the most important thing is to build a “measurement and training” integrated personnel training system. The “test and train” integrated talent development system analyzes employee tests and takes targeted training measures. The first is to carry out job competency testing. Divided into production skills personnel training and general test test, general management personnel comprehensive ability test, all levels of safety management ability on-site test, the test covers the current basic skills knowledge of each employee's position; second is to carry out an inventory of each position talent, analyze through the post test, the formation of short boards and strengths; third is to develop a targeted to make up for the short boards, promote the strengths of the ladder training; fourth is to participate in the training training to carry out training evaluations to meet expected requirements, such as not meeting the expected requirements and job skills requirements, then continue to carry out the corresponding job training until the corresponding requirements. To meet the expected requirements, such as not meeting the expected requirements and job skills requirements, then continue to carry out the corresponding job training until the corresponding requirements. Through the development of safeguards, not only to effectively ensure the effectiveness of training, enhance the quality of the talent team, improve business performance, and help the enterprise human resource management level of high-quality development.

The key to the construction of the integrated personnel training system of “measurement and training” lies in the effective realization of the conversion of competence and curriculum, that is, based on the analysis of competence requirements, the conversion of competence modules into curricula, and the implementation of specific teaching content. First, according to the results of the assessment, the position and the division of the hierarchy, the ability items and behavioral points that should be possessed by each type of personnel are sorted out and analyzed so that there are no missing points. Then, according to the description content and key points of the behavioral points, sort and classify them to form the course name. Finally, according to the needs of the position, the training courses are sorted. Among them, the key point is that, first, the content of the training course must cover all the competence items and behavioral points that the personnel at this level of this position should have, and there can be no omission. Secondly, the conversion between behavioral points and courses should be accurate, and the courses between different levels of the same post should be articulated and progressive. Third, through the training of progressive growth in the quality and ability of the training personnel, until it reaches the needs of the talent inventory.

At the same time, the “measurement and training” integrated personnel training system should build evaluation indicators, carry out post-training assessment of the learning effect of participating trainers, refine and improve the training curriculum, and enhance the effectiveness of training. The establishment of a safeguard mechanism for process control, the establishment of a pool of experts to support “measurement and training”, and the establishment of a sound incentive and assessment mechanism to ensure the synergistic development of the integration of human resources management and measurement and training.

## 5. Conclusion

This paper provides technical support for solving the resource competition and global optimization problems in enterprise multi-project human resource management scheduling by constructing a multi-level dynamic network with the improved CS-XGBoost algorithm. The CS-XGBoost algorithm is compared with the same type of traditional algorithms, and it is found that the CS-XGBoost algorithm is able to achieve the shortest duration of 510 days in three construction enterprise projects, which is shorter than the comparative algorithms by more than 10-30 days. And the number of iterations of the algorithm is only about 450 times, which is much less than the 15,000 times of the comparison algorithm. While the duration is shortened, the utilization rate of human resources is also improved. After the introduction of project multi-demand prioritization, the Pareto frontier analysis of CS-XGBoost algorithm verifies that the algorithm supports synergistic decision-making of project duration, project cost and personnel balance, and has high flexibility. Through the construction of enterprise human resource management and "measurement and training" integrated talent training system, it can effectively improve the quality and management level of enterprise human resources, comprehensively enhance the enterprise's ability to implement the results of the optimization algorithm, and promote the modernization and development of the enterprise. In future research, a real-time scheduling system can be introduced to adjust human resources scheduling according to the actual situation at any time during the project execution process, in order to adapt to the complex and changing project environment.

## References

[1] Zhang, J., & Chen, Z. (2024). Exploring human resource management digital transformation in the digital age. Journal of the Knowledge Economy, 15(1), 1482-1498.

[2] Prokopenko, O., Garafonova, O., & Zhosan, H. (2023). Digital tools in human resource management: how digitization affects personnel management. Socio-economic relations in the digital society, 4(50), 84-94.

[3] Lufa, L., Ruanggoon, J., & Tepthong, S. (2024). Digitalization of Human Resource Management: A Case Study of RM Company. Science, Technology, and Social Sciences Procedia, 2024(5), CiM07-CiM07.

[4] Kmecová, I., Stuchlý, J., Sagapova, N., & Tlustý, M. (2021). Sme human resources management digitization: Evaluation of the level of digitization and estimation of future developments. Polish Journal of Management Studies, 23(2), 232-248.

[5] Liu, Y. (2025). The Law of Data-driven on Employee Growth in Enterprise Human Resource Management in the Era of Digital Transformation. Journal of Information & Knowledge Management, 24(01), 2450103.

[6] Shah, N., Michael, F., & Chalu, H. (2020). Conceptualizing challenges to electronic human resource management (e-HRM) adoption: A case of Small and Medium Enterprises (SMEs) in Tanzania. Asian Journal of Business and Management, 8(4).

[7] Muzanenhamo, A., Khazamula, S. D., & Imbayarwo, M. (2023). Towards Achieving Electronic Human Resource Management: Challenges Facing Public Enterprises in Adopting Technology. Indonesian Journal of Innovation and Applied Sciences (IJIAS), 3(2), 111-117.

[8] Hoq, M. Z. (2021). A comprehensive review of contemporary issues of electronic human resource management (E-HRM). Global Journal of Economics and Business, 11(2), 278-296.

[9] Mkhulisi, N., Myataza, A., Mafunga, M., & Thango, B. (2024). Not peer-reviewed version A Systematic Review of ERP, CRM, and HRM Systems for SMEs: Managerial and Employee Support. CRM, and HRM

Systems for SMEs: Managerial and Employee Support (October 08, 2024).

[10] Rahman, M., Mordi, C., & Nwagbara, U. (2018). Factors influencing E-HRM implementation in government organisations: Case studies from Bangladesh. Journal of Enterprise Information Management, 31(2), 247-275.

[11] Piwowar-Sulej, K., Blštáková, J., Ližbetinová, L., & Zagorsek, B. (2024). The impact of digitalization on employees' future competencies: has human resource development a conditional role here?. Journal of Organizational Change Management, 37(8), 36-52.

[12] Rustam, A., Astuti, I. Y., & Safitri, U. R. (2024). Strategies for Improving Employee Competencies in the Digitalization Era through Training and Human Resource Development. The Journal of Academic Science, 1(7), 849-857.

[13] Cieslak, V., & Valor, C. (2025). Moving beyond conventional resistance and resistors: an integrative review of employee resistance to digital transformation. Cogent Business & Management, 12(1), 2442550.

[14] Vuong, T. D. N., & Nguyen, L. T. (2022). The key strategies for measuring employee performance in companies: a systematic review. Sustainability, 14(21), 14017.

[15] Kharub, M., Mondal, S., Singh, S., & Gupta, H. (2025). Evaluation of competency dimensions for employee performance assessment: evidence from micro, small, and medium enterprises. International Journal of Productivity and Performance Management, 74(1), 107-138.

[16] Jeffrey, I., & Prasetya, A. B. (2019). The employee performance assessment and employee training, on employee intension. Jurnal Aplikasi Manajemen, 17(1), 56-65.

[17] Zhang, S. (2021). The establishment and application of talent evaluation system: a quantitative model of individual human capital. Journal of Chinese Human Resources Management, 12(1), 18-33.

[18] Longyue, C. (2023). Application of Performance Assessment in Enterprise Employee Training. Academic Journal of Business & Management, 5(26), 125-129.