Elevator Group Scheduling by Improved Dayan Particle Swarm Algorithm in Computer Cloud Computing Environment

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Abstract

The world is entering the era of cloud computing. Due to the rapid development of computer technology, as the core content of elevator transportation technology, elevator group control dispatching systems and group intelligent algorithms will have a wide range of application prospects due to their significant advantages. The purpose of this paper is to study the elevator group scheduling problem of the improved Dayan particle swarm algorithm in the computer cloud computing environment.This article first summarizes the research status of elevator group control technology and algorithms, and then analyzes and studies the basic theory of cloud computing task scheduling. Combined with the improved Dayan particle swarm algorithm, the elevator prediction model is established. This paper systematically expounds the theory and algorithm principle of the basic particle swarm algorithm, and analyzes the Dayan particle swarm algorithm on this basis. In this paper, the experimental research is carried out by comparing the two algorithms on the simulation software. Research shows that the improved Dayan particle swarm algorithm has better scheduling performance than the traditional basic particle swarm algorithm.

Keywords: Cloud Computing, Dayan Particle Swarm Algorithm, Elevator Group Scheduling, Application Research

1. Introduction

Elevator group control technology is to plan all elevators in the building and divide them into different groups; then use computer processing and control by counting the changes in passenger flow in the building to find out the operation strategy of the best method of dispatching elevators in the elevator group [1-2]. This method needs to eliminate the different degrees of confusion caused by changes in the traffic flow in the building, so as to improve the transportation efficiency of the elevator, improve the service quality of the elevator, and improve the comfort of passengers on the elevator [3-4].

Since the 1940s, elevator control technology has changed from simple automatic control, collective control to later parallel control, etc., which cannot meet the increasingly high travel requirements of passengers [5-6]. With the rapid development of science and technology, the construction of cities also develops more rapidly, and more and more intelligent buildings appear in cities. The emergence of a large number of super high-rise buildings has become a kind of architectural development trend [7-8].

Compared with the more advanced technology of foreign countries, the domestic elevator group control technology has many deficiencies and is in a relatively backward state; it plays a key role in the maturity of the domestic elevator group control technology, and the design of intelligent elevator group control algorithms and it is of great significance in practice, and the engineering significance is also more prominent [9-10].

This article will study the optimal scheduling problem in group control technology. First, use different intelligent algorithms to dispatch the elevator group control system, and then make improvements, use the Dayan particle swarm algorithm for elevator scheduling, and use Matlab GUI to establish the corresponding Algorithm test simulation software platform, conduct comparative test, analyze the advantages and disadvantages of elevator optimization dispatching control algorithm.

2. Research on Elevator Dispatch Application of Improved Dayan Particle Swarm Algorithm in Computer Cloud Computing Environment

2.1. Cloud Computing Task Scheduling

According to different application scenarios of users, the technical requirements for cloud computing task scheduling are also different. The following is a traditional task scheduling algorithm for cloud computing.

Round-robin scheduling algorithm
The round-robin scheduling algorithm allocates users' new connection requests to different resources in a certain order in turn, so as to achieve load balancing of the server.

Weighted round robin scheduling
In order to overcome the shortcomings of the round-robin scheduling algorithm, different weights are used to represent the different processing capabilities of the server. When the corresponding weight of the server is larger, it means that the server has better processing capabilities, so more are allocated to the server processing tasks. Conversely, fewer tasks are allocated to the server. However, the scheduling algorithm also has its huge flaw, which is very easy to cause load imbalance.

Minimum link scheduling algorithm
The minimum link scheduling algorithm uses a load balancer to perform scheduling. When there is a task request, the load balancer records the number of connections on each server, thereby assigning new task requests to the server with a smaller number of connections.

Weighted least link scheduling algorithm
By adding weights to express the processing capacity of the server, the shortcomings in the minimum link scheduling algorithm are overcome. However, the scheduling algorithm ignores the size of the task data, so the processing effect is not good.

2.2. Analysis of Characteristics of Elevator Group Control System

Fuzzy and nonlinear
The elevator itself is a relatively complex piece of equipment. The inconsistency of input variables and the non-unique output variables, as well as complex changing parameters, all determine that it cannot be accurately described by a certain precise quantity or concept. Therefore, the elevator group control traffic system itself has a certain vagueness and special point. When we describe it as "passengers waiting for elevators are short" and "passengers need to take the elevators as short as possible", they are all of comparative significance. The concept mentioned above is very vague, without a quantitative analysis of the concept; the size of the traffic volume, the number of passengers in a single elevator, the speed of each elevator's response to the call signal, and so on.

Incompleteness and disturbance
The group control system may have the characteristics of random disturbing factors: the wrong registered call signal of the passenger; the wrong destination signal of the passenger, which causes no need to stay; the randomness of the passenger updates the time of the registered call signal, etc. These can be understood as random errors, and the control strategy needs to consider the impact of these random factors. The elevator itself also has inevitable disturbance factors: such as the noise of the power supply, the noise intruding from the input line, etc., misoperation of these systems may cause certain failures [11].

The incompleteness is mainly reflected in the following aspects:

Each elevator is equipped with a load-bearing device, and the weight difference of different people is relatively large. The device cannot accurately obtain accurate data on the number of passengers, which leads to inaccurate car congestion and passenger waiting time to a certain extent, which increases the difficulty of control. If a passenger does not register in advance when entering the car, the destination floor is also in an unknown state, and there is a large error in predicting the passenger's elevator time and other passengers' elevator time. Because of these incomplete uncertainties and other factors, it is difficult for us to quantitatively analyze and establish a more accurate model of group control system scheduling optimization [12].

Multi-objective
The elevator group control system is a system composed of multiple goals. Its diversity is reflected in the following aspects: the average time required for all passengers to wait for the elevator is minimized; the total running time of the elevator group is reduced and the number of each elevator stops is reduced to reduce energy consumption; it is hoped that the group-controlled passenger load will be maximized during peak hours. Elevator group dispatch requires the shortest possible ride and waiting time, and requires minimum energy consumption. In addition, it is also required that the elevator's ability to carry passengers is as high as possible, and it is more accurate to reach the target floor to make passengers more satisfied with the elevator. It is not difficult to see from these goals that some goals are contradictory. If one of the goals is met, other goals may not be well met. Find a balance between two goals or more to make a comparison. It is difficult to solve the problem, and finding the right balance point has become the core problem in elevator group control dispatching.

2.3. Particle Swarm Optimization (PSO)

The particle swarm algorithm was originally inspired by the activity law of the bird swarm, and then used the theory of swarm intelligence to build a simple mathematical model. It is based on the researcher's careful observation of the behavior of the animal group activities, and then through the individual sharing communication information feedback to the group to make appropriate adjustments, so that the group movement search is a process of transformation from disorder to order, and finally get the optimal solution.

The PSO algorithm is a parallel global search algorithm based on swarm intelligence, which uses speed and location search to achieve the optimization of a space. Suppose that in the D-dimensional search space, the population $X = (X_{1,} X_{2},...X_{n,});$ is composed of n particles, the i-th particle in the population represents a vector $X_i = (X_{t1,} X_{t2},... X_{tD,})^T$, and the dimension is D, which means the i-th particle is in the D dimension For the position in the space, the fitness value corresponding to the position X of each particle can be calculated according to the objective function. The velocity of the i th particle is

$$V_i = (V_{t1}, V_{t2}, ... V_{iD})^T \tag{1}$$

Its individual extreme value

$$P_i = (P_{i1}, P_{i2}, ... P_{iD})^T \tag{2}$$

The global extremum of the population

$$P_g = (P_{g1}, P_{g2}, ... P_{gD})^T \tag{3}$$

The formula for the optimization algorithm to update the particles is as follows:

$$V_{id}^{k+1} = wV_{id}^{k} + C_1^{*} r_1^{*}(P_{id}^{k} - X_{id}^{k}) + C_2^{*} r_2^{*}(P_{gd}^{k} - X_{id}^{k}) \tag{4}$$

$$X_{id}^{k+1} = X_{id}^{k} + V_{id}^{k+1} \tag{5}$$

2.4. Dayan Particle Swarm Algorithm and Its Improvement

Dayan-Particle Swarm Algorithm
The particle swarm optimization algorithm is based on the movement of the bird swarm, and the optimization algorithm obtained through practical research is mostly used in complex optimization problems, and converges to the optimal solution faster and better. Anderson and Franks optimized the PSO algorithm based on the flying characteristics of the wild geese. As one of the bird flocks, the flock of geese has certain characteristics during flight. Compared with the group movement behavior of other bird flocks, it is unique and can integrate the entire flock of geese. It is divided into two parts, the first part is the head geese, leading the flock of geese to fly, and the second part

is the follower of the geese. When the geese move south, the geese are arranged in an orderly "herringbone" or "in-line" when flying. The formation changes but the position of the head of the geese remains unchanged, thus strengthening the cooperative relationship of each geese in the flock, and at the same time promoting competition between individuals, enhancing the cohesion of the geese, and achieving the purpose of migration. When flying in a group of geese, the head geese has a certain leadership ability, and its adaptability is the highest. It determines the direction and speed of the flight of the geese. When it is applied to the PSO algorithm, the head geese is equivalent to the best particle, and the position of the particle is at a certain level. To the extent it determines the search direction and speed of other particles.

Particle update is mainly related to two values, both of which are optimal solutions. The first optimal solution is found by the particle i itself. This value can be expressed as P_{id}; the second optimal solution is based on historical fitness index ranking i. This value can be expressed as $P_{(i-1)d}$. Then, in this N-dimensional space, the position of the particle can be represented by the formula $xi = (X_{t1,} X_{t2},\dots X_{tN,})^T,$) and the velocity is represented by $V_i = (V_{t1}, V_{t2},\dots\dots V_{iN})^T$ and the individual extreme value is represented by the formula $P_i = (P_{i1}, P_{i2},\dots\dots P_{iN})^T$. At this time, the evolution equation of the geese particle swarm algorithm is as follows:

$$V_{id}^{\ t+1} = \omega \cdot V_{id}^t + c_1 r_1 (P_{id}^t - X_{id}^t) + c_2 r_2 (P^t (i-1)d - X_{id}^t$$
$$X_{id}^{t+1} = X_{id}^1 + V_{id}^{t+1} \tag{6}$$

In formula (6), $i = 1, 2, 3,\dots m, d = 1, 2,\dots, D$; the non-negative constant is represented by ω, which is an inertial factor; and the learning factor is expressed by c_1, c_2; in the formula, c_1, c_2 represents a random number and the limited range is between [0,1]; the number of iterations is represented by t in the formula. Compared with the PSO algorithm, the geese PSO algorithm not only maintains the particle diversity, but also avoids the local optimal risk, but the result is not significant.

Improved Dayan Particle Swarm Algorithm (FO-GPSO) based on fractional calculus
The time-domain fractional differential equation defined by Grunwald-Letnikov is:

$$D^{\alpha}_{[X(t)]} = \lim_{h \to 0} \left[\frac{1}{h^{\alpha}} \sum_{k=0}^{+\infty} \frac{(-1)(\alpha+1)x(t-kh)}{\Gamma(k+1)\Gamma(\alpha-k+1)} \right] \tag{7}$$

According to formula (7), it can be found that through the concept of derivatives, although both integer-order derivatives and fractional-order derivatives have a finite hierarchy, the latter has an infinite number of terms. Taking fractional calculus as a global operator, and comparing it with integer calculus, the most obvious difference is that the former is related to all historical point information. The specific formula for applying fractional derivatives to solve the limit value under the discrete-time model can be expressed approximately in the following form:

$$V_{id}^{\ t+1} = \omega \cdot V_{id}^t + c_1 r_1 (P_{id}^t - X_{id}^t) + c_2 r_2 (P^t_{\ (i-1)d} - X_{id}^t) \tag{8}$$

In formula (8), the sampling period is expressed by T, and the cut-off order is expressed by r. The fractional-order model established on this basis has a certain degree of memory, and the model describes irreversibility and chaos with a high fitness value. Therefore, using fractional-order thinking as a guide, it is applied to describe the evolutionary process with a certain perturbation propagation. At the same time, the continuous dynamics and evolution of particles in the particle swarm can be described, which can broaden your thinking to analyze and solve problems. Through fractional calculus to realize the optimization of the update speed of the geese group PSO, the new formula can be derived as follows:

$$V_{id}^{\ t+1} = \omega \cdot V_{id}^{t} + c_1 r_1 (P_{id}^{t} - X_{id}^{t}) + c_2 r_2 (P^{t}_{(i-1)d} - X_{id}^{t}) \quad (9)$$

According to formula (9), set where ω= 1 and $V_{id}^{\ t+1} = \omega - v_{id}^{t}$ belong to the derivative, expressed in discrete form, and the order is $\alpha = 1$ (assuming), and the derived formula is as follows:

$$D^{\alpha}\left[V^{t+1}\right] = c_1 r_1 (P_{id}^{t} - X_{id}^{t}) + c_2 r_2 (P^{t}_{(i-1)d} - X_{id}^{t}) \quad (10)$$

Through the application of the related ideas of fractional calculus, the speed derivative order can be extended to between [0,1], which makes the evolution of the particles in the model more stable, and at the same time can improve the persistence and long-term effect of the model's memory effect. After improving the PSO algorithm, analyze the impact of α value changes on its performance, let α change from 0 to 1, and step $\Delta\alpha = 0.1$ to converge to the optimal solution. According to experiments, the performance of the improved PSO algorithm is the best when $\alpha = 0.6$. However, fractional calculus is an infinite dimension, and its memory is infinite, which makes it more difficult to realize the number. At this time, r=4, which means that considering the first four items, the formula can be derived:

$$v^{t+1} = \alpha v^{t} + \frac{1}{2} v^{t-1} + \frac{1}{6}\alpha(1 - \alpha) v^{t-2} + \frac{1}{24}\alpha(1 - \alpha)(2 - \alpha) v^{t-3} + c_1 r_1 (P_{id}^{t} - X_{id}^{t}) + c_2 r_2 (P^{t}_{(i-1)d} - X_{id}^{t} \quad (11)$$

After many verifications, the change of r value will have a certain impact on the performance of the improved PSO algorithm. When r=4, the performance of the improved PSO algorithm is the best.

2.5. Establishment of Fo-Gpso Elevator Prediction Model Based on Cloud Computing Task Scheduling

Input selection

Based on the theory of phase space reconstruction and Takens theorem as the criterion, it is to reconstruct the trajectory of the phase space in the embedded space through the more adaptive embedding dimension and delay time. Compared with the original system, the dynamic Aspects are equivalent. The input parameters of the traffic flow support vector machine model in this paper are the vectors generated by phase space reconstruction, and then use the mapping of the SVM kernel function to map the obtained traffic flow data sequence to the high-dimensional space, and the information carried in the sequence is high. It is reflected in the three-dimensional feature space to construct a traffic flow prediction model based on SVM.

The original input parameters are reconstructed to reconstruct the phase space, so that the input $X(t) = (x(t), x(t + \tau),\ldots, x(t + (m - 1)\tau))$ and the output $y(t) = \{x(t + 1)\}$ form a mapping relationship $f: R^{m} \rightarrow R$. At this time, the support vector machine model is trained. For example, when t=1, the input $X(1) = (x(1), x(1 + \tau),\ldots, x(1 + (m - 1)\tau))$ is obtained, and the support vector machine prediction model is obtained. The support vector machine is trained in this way by changing the value of t, that is, performing different inputs.

Parameter selection

After clarifying the input of the support vector machine, you need to select the appropriate kernel function type. This is also the most critical link. It is directly related to whether the prediction can be achieved. When selecting the kernel function, the more widely used ones are listed in Table 2-1 above. Among the four kernel functions with higher usage, the Gaussian kernel function has a wider choice of sample size and a wider use of dimensional space, and the mapping effect of high-dimensional and low-dimensional spaces is better. Under this condition, the kernel function of the SVM in this paper is finally determined as a Gaussian kernel function, and the corresponding expression is as follows:

$$K(x_i, x) = exp\left\{-\left|x - x_i\right|^2/2\sigma^2\right\} \quad (12)$$

In formula 12, $K(x_i, x)$ is used as the expression of the kernel function, and users can set the kernel parameters σ according to their needs. At the same time, the kernel parameter σ determines the performance of the prediction model to a certain extent, mainly because when the kernel parameter σ changes, the mapping function also changes. At this time, the sample subspace distribution also changes, and the complexity is changed.

(3) Simulation examples and result analysis
In this paper, the constructed SVM prediction model is used to predict the typical chaotic elevator traffic flow, and the input parameter is determined as the vector of phase space reconstruction. The three key parameters $\sigma, C, and\ \varepsilon$ of the support vector machines are optimized by the PSO algorithm. In order to further ensure that the above methods are objective and effective, this article evaluates the prediction effect, mainly using the average absolute error MAE etc. to carry out the error in the model. The formula is as follows:

$$MAE = \frac{1}{N}\sum_{t-1}^{N}|\hat{a}(t) - x(t)| \quad (13)$$

In formula 13, N represents the number of samples, that is, the number of traffic flow samples for centralized inspection. At this time, 144 samples are selected. The t in represents the time, and x(t) this term represents the traffic passenger flow value at this time. Comparing with , the x(t) xˆ(t) former is the actual value, and the latter is the predicted value.

3. Experimental Research on Elevator Dispatching of Improved Dayan Particle Swarm Algorithm in Computer Cloud Computing Environment

3.1. Experimental Protocol

In the programming environment of MATLAB, the scheduling algorithm of Dayan particle swarm algorithm is tested and simulated under different traffic passenger flow modes. And under the same traffic passenger flow pattern and the same group control model, it is compared with the traditional particle swarm optimization algorithm for simulation analysis; the shortest waiting time scheduling method is to take the length of passenger waiting for the elevator as the only performance indicator, and finally select the elevator with the shortest waiting time responds.
The above-mentioned simulation is a test analysis made by ignoring some random factors such as passengers pressing the call button by mistake or changing halfway, and does not include some special situations. For different modes, the weight of each performance index is changed in time.

3.2. Research Methods

Comparative analysis method
In this experiment, the Dayan particle swarm algorithm was compared and analyzed with the traditional basic particle swarm algorithm, and the results obtained were analyzed as a whole. These data provide a reliable reference for the final research results of this article.

Observation method
This experiment observes and records data on the running time and efficiency of the two algorithms on the simulation software. These data not only provide a theoretical reference for the topic of this article, but also provide data support for the final research results of this article.

Mathematical Statistics
Use the relevant software to carry on the statistical analysis to the research result of this article.

4. Experimental Analysis of Elevator Dispatching with Improved Dayan Particle Swarm Algorithm in

Computer Cloud Computing Environment

4.1. Analysis of the Peak Situation of Upstream Passenger Flow

In order to make this experiment more scientific and effective, this experiment uses two algorithms to simulate the peak passenger flow situation on the simulation software. The data obtained is shown in Table 1.

Table 1. Analysis of the peak situation of upstream passenger flow

	1	2	3	4	5	Avg
Average waiting time(FO GPSO)	22.7	22.48	26.37	19.37	20.18	22.15
Average waiting time(PSO)	24.82	23.63	28.56	9.99	21.54	23.71
Average ride time(FO GPSO)	35.01	27.58	26.40	26.34	32.58	29.58
Average ride time(PSO)	35.26	29.89	30.85	34.79	40.02	34.16
Start and stop times(FO GPSO)	55	39	35	30	46	41
Start and stop times(PSO)	56	40	39	12	48	43

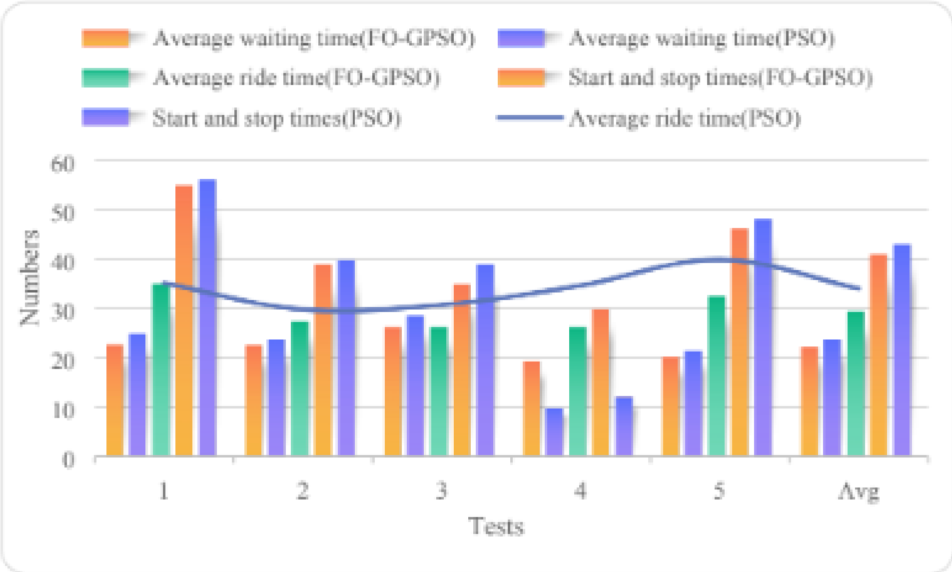

Figure. 1. Analysis of the peak situation of upstream passenger flow

It can be seen from Figure 1 that in the scheduling process of Dayan Particle Swarm Optimization, the average waiting time for elevators and the average elevator riding time are reduced, and the number of elevator starts and stops is also significantly less. Therefore, the PSO algorithm has been improved after the improvement. It is operable.

4.2. Analysis of the Peak Situation of Downstream Passenger Flow

In the simulation, two traffic passenger flow modes are selected for the simulation of the dispatching algorithm, and the downlink passenger flow traffic mode is subjected to the simulation experiment. The data obtained is shown in Table 2.

Table. 2. Analysis of Downstream Passenger Flow Peak Situation

	1	2	3	4	5	Avg
Average waiting time(FO GPSO)	26.33	25.23	27.34	25.63	27.45	29.40
Average waiting time(PSO)	27.56	26.46	28.69	30.25	28.15	28.02
Average ride time(FO GPSO)	33.26	32.89	29.45	34.51	27.16	31.45
Average ride time(PSO)	35.87	36.55	32.01	35.89	29.48	33.96

Start and stop times(FO GPSO)	47	40	37	38	49	42.2
Start and stop times(PSO)	48	42	39	40	51	44

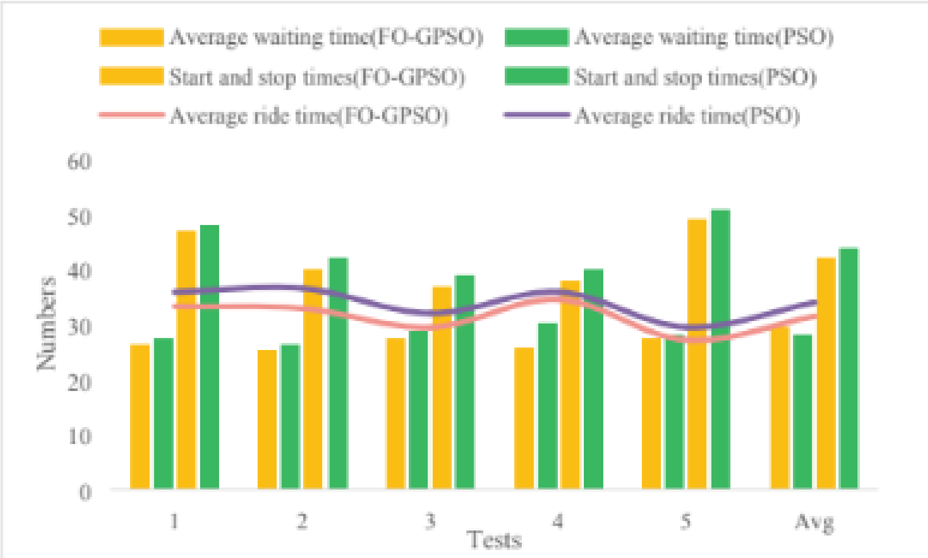

Figure. 2. Analysis of Downstream Passenger Flow Peak Situation

It can be seen from Figure 2 that the Dayan particle swarm algorithm and the basic PSO algorithm are respectively applied to the elevator group control dispatching system for simulation operation. The average waiting time for passengers and the average time for passengers on the elevator are significantly reduced, and the long waiting rate is reduced by 0.032. The number of stops is reduced, so the improved particle swarm algorithm has a better optimization effect.

5. Conclusion

This article takes the dispatching system of elevator group control as the research object. After a comprehensive analysis of the characteristics of the passenger flow in the intelligent building and the characteristics of the group control dispatching system itself, combined with the swarm intelligence algorithm-particle swarm optimization algorithm, the Dayan particle swarm algorithm is proposed to be applied to the elevator group control multi-objective optimization dispatch. And the improved algorithm is tested on the convergence speed and the ability to jump out of the local optimum, and simulation is used to prove that the improved algorithm can be applied to multi-objective scheduling and obtain more optimized effects.

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