

# Optimal Multi-Resource Scheduling Strategy Simulation Based on Improved Genetic Algorithm

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## Abstract

*In order to prevent large-scale cloud space scheduling conflict, achieve reasonable dispatch of cloud computing resources. By conducting a detailed analysis of the cloud resources scheduling process, improved genetic algorithm is proposed based on cloud computing resource scheduling model. In this model, firstly, the resource scheduling sequences of cloud computing are encoding into chromosomes. Then in the scheduling process, load balancing degree of the cloud computing model is regarded as the optimization objective, aiming at the non-optimal problem occurred in scheduling process. By genetic algorithm selection, crossover and mutation operation, continue to search to find the optimal cloud computing resources scheduling scheme. Finally, simulation is operated on CloudSim platform. Simulation results show that, compared to traditional particle swarm optimization algorithm, which basically meet the requirements of automatic scheduling algorithm in the cloud computing environment, such as stability, reliability and high precision, not only improves resource utilization of cloud computing, but also shortens task completion time, while for rational management study of cloud computing resources provides theoretical reference, and promotes the continuous development of the research field.*

**Keywords:** cloud computing, resource scheduling, improved genetic algorithm, genetic operation

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## 1. Introduction

In recent years, with the rapid development of all kinds of social network and mobile Internet, the needs of people is transformed gradually from a purely functional device into the network which have great service quality in aspects, like accessibility, sharing, security, openness and ease of use, in order to ensure that they can access the services they need easily at any time, any place, any device can, and to ensure that their information will not be subjected to any threats and constraints in the case, so that they can communicate with others and sharing conveniently [1]. Cloud computing concept proposed and generated just to meet this demand changes. It is gradually perceived by academia and industry as an emerging resource use and delivery models. In addition, it is seen as the third wave of IT following the personal computer revolution and the Internet revolution. It will bring about fundamental changes to people's lives, production methods and business models, therefore in the computer science community, it has become a hot research topics [2-5].

Traditional algorithms have parallel search capabilities, thus they can find the optimal scheduling scheme cloud computing resources fast, and enable to improve cloud computing resource efficiency. However, the algorithms which belong to heuristic algorithms are unable to overcome their own local optimal solution, so the convergence is slow and optimization result is unstable, it is sometimes difficult to obtain global optimal resource scheduling scheme [6-9]. Therefore, it is necessary to raise an improved heuristic algorithm.

For these problems, this paper proposes an cloud computing resource scheduling program based on improved genetic algorithm (modify genetic algorithm, MGA), and simulation is used to verify its effectiveness and feasibility, in order for the program to achieve cloud computing resource scheduling optimization, improve utilization of computing resources, and reduce the task completion time [10].

## 2. Cloud Computing Resource Scheduling Problem

The underlying physical resources in the cloud computing environment include a variety of resources, such as processor, memory, hard disk and network bandwidth. How to schedule cloud computing users' job tasks reasonably to make the mapping among the physical resources, virtual machine and job tasks reach the optimal combination is a key issue for the resource scheduling in cloud computing environment [11, 12].

In the IaaS cloud computing environment, assuming that the resource set in a resource pool mainly consisted of three types of resources, that is, processor resources, memory resources and disk resources,  $r_1$  represents the processor resources,  $r_2$  denotes the memory resources, and  $r_3$  means the disk resources. When the user requests a service to the cloud management platform, cloud computing management platform assigns three corresponding number of resources for the tasks, and are virtualized as a separate virtual machine, and their tasks are performed in the corresponding virtual machine [13, 14]. It is clear that the task start time and end time for each task perform operations in the virtual machine are the same.

As is shown in Figure 1, three types of resources in a node are taken for an example. There are two job tasks,  $J_1$  and  $J_2$ , the proportions for each task are different. Three types of resources  $r_1$ ,  $r_2$ ,  $r_3$  in the corresponding virtual machine take the proportion of physical resources for 30%, 40%, 20% and 20%, 25%, 50% respectively. It is obvious that in this node, the corresponding disk resources and processor resources for task  $J_1$ , and the corresponding processor resources and memory resources for task  $J_2$  are not fully allocated. Therefore, the multi-resource scheduling in cloud computing environment is likely to cause the waste of resources and generate the resource fragmentations, resulting in low resource utilization and other problems.

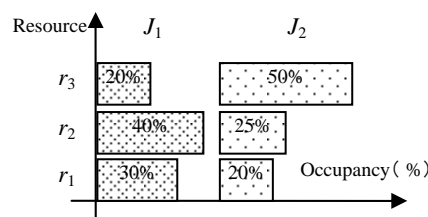


Figure 1. Task Allocation for Multiple Resources

## 3. The Solution of Cloud Computing Resource Scheduling

### 3.1. The Modify Genetic Algorithm of Cloud Computing Resource Scheduling

#### (1) Chromosome coding

Supposing  $v_i = 1, 2, \dots, m$  is the number of resources of cloud computing, and  $p_i = 1, 2, \dots, n$  is the number of physical resources in cloud system. In order to facilitate the calculation, the serial number is used as the planning of individual coding. First the scheduling of cloud computing resources need be sequenced, suppose it is  $v_1, v_2, \dots, v_m$ . Then the cloud computing resources are scheduled according to the sequence, assume the schedule array is  $v_{a1}, v_{a2}, \dots, v_{am}$  where  $v_{ai} \in p_i$ . Therefore, the scheduling model is corresponding to  $v_i$ ,  $i=1, 2, \dots, m$ , whose mapping physical resources are  $v_{ai}$ . The coding method in the algorithm is  $v_{a1}, v_{a2}, \dots, v_{am}$ .

#### (2) Modest function

In cloud computing systems, the goal of resource scheduling optimization is to make the load balance on the various resources. To an individual, a viable cloud computing resources scheduling scheme  $(v_{a1}, v_{a2}, \dots, v_{am})$ , the definition of the equilibrium degree of CPU, memory and bandwidth are shown as follows:

##### 1) The equilibrium degree of CPU property

$\Gamma_{ctotal} = \sum_{i=1}^m c_{vi} / \sum_{i=1}^n p_{vi}$  ,  $\Gamma_{ci} = \sum_{i=1}^m c_{va_i} / c_{pi}$  , The equilibrium degree of CPU property can

be expressed as:

$$p_c = \sqrt{\sum_{i=1}^m (\Gamma_{ci} - \Gamma_{ctotal})^2} \quad (1)$$

And we have  $c_{va_i} = \begin{cases} c_{vi} & , a_i = 1 \\ 0 & , otherwise \end{cases}$ .

2) The equilibrium degree of memory property:

$$p_m = \sqrt{\sum_{i=1}^m (\Gamma_{mi} - \Gamma_{mtotal})^2} \quad (2)$$

3) The equilibrium degree of bandwidth property:

$$p_b = \sqrt{\sum_{i=1}^m (\Gamma_{bi} - \Gamma_{btotal})^2} \quad (3)$$

Therefore, the optimal solution for cloud computing resources scheduling is to make the CPU, memory and bandwidth properties change least with the resources. The fitness  $Fit(i)$  is defined as:

$$Fit(i) = a \times p_c + b \times p_b + m \times p_m \quad (4)$$

Then, we have  $a + b + m = 1$ .

(3) Select action

The select operation mainly determines reorganization or cross individual, and the offspring number of individual elected. This paper adopts the roulette wheel selection based on row of filling. To the chromosome whose fitness is  $f_i$ , its choice probability  $Sp$  is described as

$$f_i = 1 - \frac{f_i}{\sum_{k=1}^N f_k} \quad (5)$$

(4).Cross-operation

In cloud computing resource scheduling, each chromosome is composed by pairing strings and scheduling strings. Pairing strings adopt uniform replacement cross, while scheduling strings choose random cross.

1) The uniform replacement crosses for paired strings. A binary mask string is generated randomly with the same length of the pairing string, and a binary standard quantity is set as  $j=0$  or  $j=1$ . Then compare a parent of individual strings to the mask string, the value on effective position is retained. Finally fill the value filtered out from another parent individual string, so that chromosomes exchange is completed.

2) The randomly cross for scheduling strings. The cross point is selected randomly, the genes in front of which are not change. Genes back of the point are rearranged according to the order of matching pairs.

(5) Termination condition

For the cloud resource optimization scheduling process, if it is found that individuals in a population evolution have stabilized, the iteration of the algorithm is terminated.

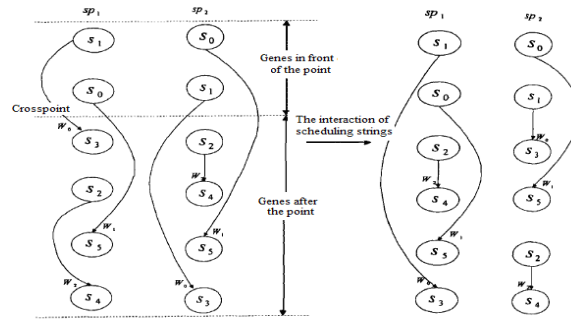


Figure 2. The Interaction Process for Scheduling Strings of Chromosomes

**3.2. Cloud Resource Scheduling Processes of Genetic Algorithm**

- (1) Population is initialized based on cloud computing resources system.
- (2) Individual Evaluation. The fitness of individual in population  $P(t)$  is calculated by Equation (3). Then the fitness of each path in the population is obtained.
- (3) Selection operation. The better individual in the population is selected through the operation according to the selection operator.
- (4) Crossover operation. Through the method described above, the crossover operation for the individual groups is carried out to produce new offspring.
- (5) Mutation operation. The mutation operation is carried out for preserved individual to generate mutation individual. The offspring  $P(t+1)$  of population  $P(t)$  is obtained through selection, crossover and mutation operation.
- (6) Judgment. If the number of generation is less than the specified maximum number, turn to Step (3). Or else, the optimal solution can be chosen from the final population.
- (7) The best individual is decoded to obtain the optimal scheduling scheme for cloud computing resources

Workflow of cloud resource scheduling model based on modify genetic algorithm is shown as Figure 3.

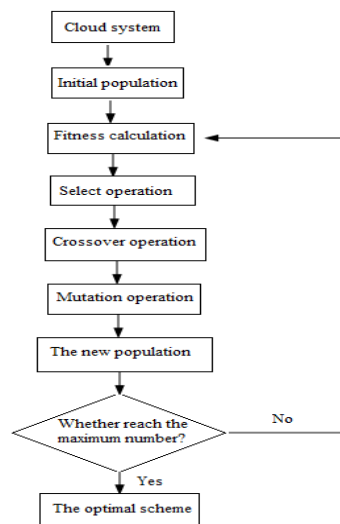


Figure 3. Workflow of Cloud Resource Scheduling Model Based on MGA

In order to carry out rational allocation for a variety of resources in the cluster on the cloud computing management platform, the classification mining module is adopted to mine the mapping among the various resources, user requests and virtual machines, and then generate

the classification rule and model to guide the resource allocation. The subsequent section mainly introduces the mapping process between resources and virtual machines in the MRS module. Assuming that there are  $m$  physical nodes in the cluster environment, and they are  $\{P_1, P_2, \dots, P_m\}$  respectively. The processor resources, memory resources and disk resources of the  $i$ -th ( $1 \leq i \leq m$ ) node are  $r_{1i}, r_{2i}, r_{3i}$  respectively. Then, all the processor resources are  $C =$

$\sum_{i=1}^m r_{ci}$ , memory resources are  $M = \sum_{i=1}^m r_{mi}$ , and disk resources are  $N = \sum_{i=1}^m r_{ni}$ . For simplicity, the number and size of resources for each physical node in cluster environment are set the same. The resource type between nodes is isomorphic, that is,  $r_1 = r_{11} = \dots = r_{1m}$ ,  $r_2 = r_{21} = \dots = r_{2m}$ ,  $r_3 = r_{31} = \dots = r_{3m}$ , then  $C = m * r_1$ ,  $M = m * r_2$  and  $N = m * r_3$ . is  $C = m * R_1$ ,  $M = m * R_2$ ,  $N = m * r_3$ . The task request set  $J$  with  $n$  users is  $\{J_1, J_2, \dots, J_n\}$ . The three type of resources requested by the job task  $j$  are denoted by  $R_{1j}$ ,  $R_{2j}$ ,  $R_{3j}$  respectively, then the total processor resources of all the

job requests is  $Cr = \sum_{j=1}^n R_{1j}$ , the total memory resources of all the job requests is  $Mr = \sum_{j=1}^n R_{2j}$ ,

and the total disk resources of all the job requests is  $Nr = \sum_{j=1}^n R_{3j}$ . The set of virtual machines VM is  $\{vm_1, \dots, vm_n\}$ . Therefore, in order to maximize the resource utilization, there exists  $|C - Cr| \rightarrow 0$ ,  $|M - Mr| \rightarrow 0$ ,  $|N - Nr| \rightarrow 0$ .

Table 1 lists the mapping between three resources in the two physical nodes  $\{P_1, P_2\}$  and 3 virtual machines  $\{vm_1, vm_2, vm_3\}$ . The classification mining operation for transaction set in Table 1 is carried out based on the improved Apriori algorithm. Assuming that, the minimum support count  $min\_sup = 2$ , the frequent pattern set  $\{<r_{11}, r_{21}, vm_1>, <r_{13}, r_{23}, vm_3>, <r_{22}, r_{32}, vm_2>\}$  including the virtual machines  $vm_j (1 \leq j \leq 3)$  can be drawn.  $VM_j (1 \leq j \leq 3)$ , including:  $\{<r_{11}, r_{21}, vm_1>, <r_{13}, r_{23}, vm_3>, <r_{22}, r_{32}, vm_2>\}$ . The minimum confidence is set  $min\_conf = 70\%$ , the classification rules mode between the three kind of resources and virtual machines can be derived as:  $vm_1 \Rightarrow r_{11} \wedge r_{21}$ ,  $vm_3 \Rightarrow r_{13} \wedge r_{23}$ ,  $vm_2 \Rightarrow r_{22} \wedge r_{32}$ .

Table 1. The Mapping Table

ID	Computing	Memory	Disk	Visual machine
1	r11	r21	r31	vm1
2	r12	r22	r32	vm2
3	r11	r22	r32	vm2
4	r11	r21	r32	vm1
5	r13	r23	r31	vm3
6	r13	r22	r32	vm2
7	r13	r23	r32	vm3
8	r13	r23	r33	vm3

From the classification rules generated by the classification mining, the processor resources and memory resources in visual machine  $vm_1$  are obtained from the physical node  $P_1$ , the memory resources and disk resources in visual machine  $vm_2$  are obtained from the physical node  $P_2$ , and the processor resources and memory resources in visual machine  $vm_3$  are obtained from the physical node  $P_3$ . Therefore, the mapping rules between the virtual machines and physical resources are generated. Similarly, the classification mining is carried out to the history information of the user requests to the virtual machine, thereby obtaining the mapping mode between the user and the virtual machine.

## 4. Simulation

### 4.1. Simulation Environment

In order to test the effectiveness of resource scheduling model based on MGA cloud calculation, software Gridsim is chosen to simulate a local field of cloud computing. To measure the advantages and disadvantages of MGA scheduling program, the basic genetic algorithm (GA) is selected as a comparison model. Parameter settings: population size is 50, crossover and mutation probability are 0.9 and 0.01.

**4.2. Resource Parameters**

The range of CPU is [200 2000], the range of memory (RAM) is [100 500], and the range of Band Width is [5 200]. The detail parameters are shown in Table 2.

**Table 2. Physical Parameters**

RAM	RAM	CPU	Band Width
292	393	1036	169
468	264	2031	134
1590	1063	718	124
157	818	668	104
79	1532	204	92

**4.3. Results and Analysis**

After 100 times operation, the average value of each model is selected as the final result of the algorithm. The balance of CPU, memory and Band Width of three models are shown in Figure 4 to Figure 6.

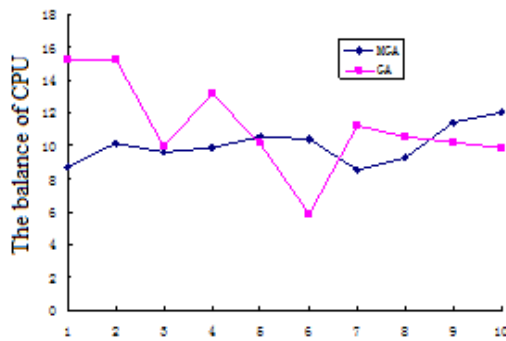


Figure 4. The Balance of CPU

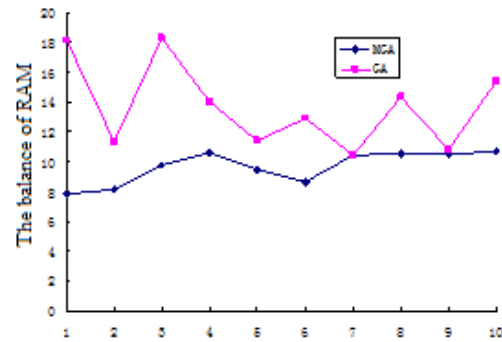


Figure 5. The Balance of RAM

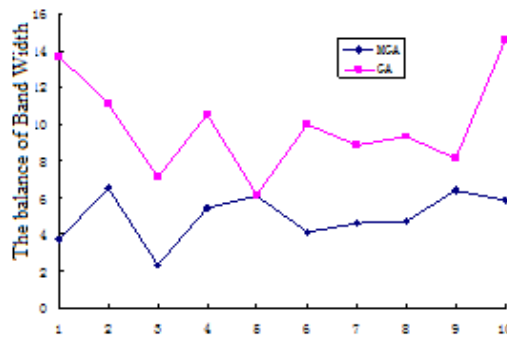


Figure 6. The Balance of Band Width

By analyzing the results of GA in Figure 4 to Figure 6, we can obtain that comparing to GA algorithm, MGA can get better scheduling scheme of cloud computing. The improvement of GA in this paper prevents the phenomenon of involving into local optimum in late search, provides more accurate descriptions of characteristics of cloud computing resources such as large-scale, shared and dynamic. In addition, it can allocate computing resources more reasonable to, improv the resource utilization of cloud computing. Thus, it is an effective cloud computing resource scheduling model.

## 5. Conclusion

Resource Scheduler is the core issue in cloud computing. The problem of target allocation resource scheduling has been extensively studied, including genetic algorithms and integer programming algorithms dominate. Genetic algorithm is a random search algorithm simulated the natural process of biological evolution. It is a classical optimization algorithm. Its main characteristic is to take groups in the population search strategy and exchange of information between individuals, use simple coding techniques and reproduction mechanisms to represent complex phenomena. It is without restrictive assumptions search space constraints, of which continuity, derivative exists and unimodal assumptions are not required. In recent years, genetic algorithms have been successfully used in industrial, economic management, transportation, industrial design and other different fields, to solve many problems.

However, the genetic algorithm also has flawed: usually expressed in slow convergence of the optimization process, and with the poor stability. In real applications, due to various reasons, the objective function of premature local optima convergence appears premature. Therefore, in order to solve the practical problems, researchers have constantly proposed a variety of improved scheme for genetic algorithms.

Cloud computing resource scheduling problem has always been one of the core issues of cloud computing. Li Jianfeng, who proposed a dual fitness with genetic algorithm (DFGA) based on mapreduce model, for the resource scheduling in cloud computing research; IBM cloud computing platform used the performance of priority scheduling policy in this research field. However, due to cloud computing research is in its infancy, the resource scheduling current for cloud computing is not yet in-depth, and cloud computing environment resource nodes are uncertainty. To solve these problems, in this paper we used the global search capability of genetic algorithm, proposed a resource scheduling model based on the improved genetic algorithm and then made the simulation experiments to verify the research proposal. The results show that the proposed MGA which was used in this paper of has the advantages of simple and fast in searching process etc. Moreover, it can quickly find the best solution for the resource scheduling problem in cloud computing environment and have a broad application prospects.

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