Cloud Computing Resource Scheduling Based on Improved Particle Swarm Optimization Algorithm

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Abstract. With the limited resources of Cloud computing (hereinafter referred to as CC), we must improve the quality of scheduling and cost optimization. Therefore, we must organically integrate the resource pool of servers and computers, which will distribute resources dynamically according to the needs of users. Through CC Resource scheduling (hereinafter referred to as RS), we can improve resource utilization, which will greatly reduce the use cost. Through the CC sharing architecture model, we can implement QoS according to different needs of users, which can achieve flexible resource allocation. Therefore, we need to reasonably design the CC RS and allocation model, which will improve the resource utilization. At the same time, this algorithm can share information among individuals. However, the general PSO (hereinafter referred to as PSO) algorithm has the problem of discretization. This paper proposes an Improved PSO (hereinafter referred to as FPSO) algorithm, which can better solve the RS problem. Firstly, the goal of task scheduling is proposed. Then, an FPSO algorithm is proposed. Finally, some suggestions are put forward.

Keywords: Improved Particle Swarm Optimization, Cloud Computing, Resource Scheduling

1. Introduction

With the development of cloud technology, the magnitude of big data has been greatly increased, which requires us to continuously improve the computing power and RS ability of CC, which will better improve the work efficiency [1]. CC is the integration of multiple technologies, which can optimize the RS problem. RS must consider the relationship between the minimum execution time and the minimum cost, which is the necessary cost of task completion. Through the CC platform, we can make clear the use cost of computing resources. In order to meet the requirements of people, we must make full use of CC resources. By optimizing RS, we can improve the scheduling mode of grid computing [2-5]. CC RS is a complex NP hard problem, which requires us to adopt swarm intelligence optimization algorithm, including genetic algorithm, PSO algorithm, ant colony optimization algorithm and so on. PSO is an optimization algorithm with adaptive search ability, which can realize the information sharing among
individuals in the group. This paper improves the PSO algorithm, which can solve the discretization problem [6].

2. Objectives of task scheduling

2.1. Optimal time span

Time span is the time consumed by CC system to complete the task. Therefore, the most important thing in CC is the optimal time span, which can achieve the shorter task span. The optimal time span will obtain better satisfaction. However, the optimal time span often leads to high cost, which will lead to the increase of enterprise operation cost. So, CC system must improve resource utilization, which will be more processing tasks. By increasing the resource throughput rate, enterprises can get more economic benefits [7].

2.2. QoS

CC is a business computing model, which needs to meet the needs of user service quality. QoS is a parameter to describe network performance, which can be described by different parameters. Through QoS, we can reflect the satisfaction of users to the service. At the same time, QoS can be expressed by a variety of parameters, such as response time, execution cost, reliability, security, and execution success rate [8].

2.3. Load balancing

Load balancing is a state to ensure the even distribution of scheduling tasks in CC. In the process of task scheduling, we must achieve resource load balancing, which will avoid the idle or overload of a node. Through load balancing, we can improve the stability of the system, which will increase the system resource ratio [9].

2.4. Economic principles

CC system contains resources with different parameters. Therefore, when scheduling tasks, the running speed and task completion efficiency of the system will be greatly different, which will lead to different charges [10]. According to different requirements of users, the system can allocate different resources, which also needs to customize different charging standards. In order to achieve the optimal allocation of resources, enterprises must ensure that service providers and users benefit together [11].

3. Correlation algorithm

3.1. Mathematical model of RS in CC

CC is an on-demand service model. CC resources are heterogeneous. Therefore, there are many similarities between RS and grid computing. CC is the virtualization technology RS, which usually adopts the Map/ Reduce step-by-step processing technology, as shown in Figure 1. Before the establishment of CC RS mathematical model, this paper must make three assumptions. First, the performance of resources can fulfill the requirements of any task. Second, all tasks can be fully allocated. Third, a task can only be assigned to one resource.
3.2. PSO algorithm

PSO is a kind of population optimization algorithm with adaptive search ability, which can realize the social sharing of information among individuals in the group. PSO has many advantages, such as less parameters, simple structure, easy to implement and so on. In recent years, PSO has been applied to many fields. However, the traditional PSO algorithm has some obvious shortcomings, such as easy to fall into local optimum, slow convergence speed, poor robustness and so on.

The mathematical formulation of PSO algorithm can be described as follows. The particle swarm composed of \( n \) particles searches the \( Q \)-dimensional space. The position of each particle can be marked as \( x_i = (x_{i1}, x_{i2}, ..., x_{iQ}) \). The corresponding velocity is expressed as \( v_i = (v_{i1}, v_{i2}, ..., v_{iQ}) \). The historical best value experienced by individual \( p_i \) \((p_i = (p_{i1}, p_{i2}, ..., p_{iQ})\) \) and the best value \( p_g \) \((p_g = (p_{g1}, p_{g2}, ..., p_{gQ})\) searched globally. The update speed of PSO algorithm is shown in Formula 1, and the position is shown in formula 2.

\[
\begin{align*}
    v_{id}^{k+1} &= \omega v_{id}^k + c_1 r_1(p_{id}^k - x_{id}^k) + c_2 r_2(p_g^k - x_{id}^k) \\
    x_{id}^{k+1} &= x_{id}^k + \gamma v_{id}^{k+1}
\end{align*}
\]

3.3. FPSO algorithm FPSO

The improved PSO mainly integrates the load index and QoS index into the algorithm, which is mainly reflected in the initialization and fitness function of PSO. In this paper, the fitness of particles can be calculated, as shown in Formula 3.

\[
Pr(ank(S_i)) = \min E(S_i), LifeTime(S_i) + \left[ l_{rc} \frac{1}{b_{rc}} + \sqrt{\sum_{i=1}^{n} (k_i a_i^2)} \right]
\]  

Figure 1. Operation mechanism of MapReduce programming model
Among them, $E(S_i)$ is the average execution time of virtual machine, and $LifeTime(S_i)$ is the lifetime of $S_i$. $\text{l}_{sc}$ is the amount of data to be transferred between $S_i$ and VMMonitor (c). $b_{sc}$ is the network bandwidth transmitted between $S_i$ and VMMonitor (c). $a_{ij}$ is the selected load index, and $k_i$ is the weight.

4. Test and result analysis

This paper selects sphere, Rosenbrock, Griewank standard test functions to test the performance of PSO and FPSO. Through the extension of cloudsim CC simulation platform, this paper simulates the computing and network resources of CC. The results are shown in Figure 2-4.

![Figure 2. Comparison of iterative convergence](image1.png)

![Figure 3. Completion time comparison](image2.png)
As shown in Figure 2, FPSO has faster convergence. As shown in Figure 3, the FPSO has a faster speed when the tasks are the same. As shown in Figure 4, FPSO has higher load balancing. PSO resource allocation algorithm is relatively simple. FPSO resource allocation algorithm allocates resources dynamically, which can balance the load of each virtual machine. Therefore, compared with PSO, FPSO speeds up the RS, which can effectively shorten the task completion time.

5. Conclusion

Through FPSO, we improve the resource utilization of CC system, which can better optimize the RS and allocation model of CC. By describing the RS problem in CC system, this paper constructs an objective function with the task completion time as the optimization object. Finally, this paper verifies the iterative convergence, computational efficiency, load balancing and so on. The test results show that FPSO has better performance.

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