Application of Ant colony Algorithm in Cloud Resource Scheduling Based on Three Constraint Conditions

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Abstract. Aiming at the problem of resource scheduling in cloud computing, an ant colony algorithm based on the three constraint conditions is proposed. The implementation of this method is divided into three steps: With the help of the information elicitation factor and expect inspiration factor, with the help of the pheromone intensity design pheromone update strategy, with the help of three constraints to complete the optimization process. Experimental results show that the three constraint conditions ant colony scheduling algorithm can complete the resource scheduling in a shorter time, and the load distribution of the scheduling results is more balanced.

Keywords: cloud computing, resource scheduling, ant colony algorithm, pheromone.

1 Introduction

At present, there are more researches on user job scheduling of and resource scheduling in cloud computing. For the cloud of job scheduling, Guo proposed the Meta-scheduling model and the Meta-scheduling policy of a cloud environment. The model and job scheduling strategy can ensure that the entire data center's power consumption or carbon dioxide emissions minimum [1]. Alrokayan uses the cloud to expand the cluster to deal with the local cluster resource scarcity, and use some job scheduling strategy to evaluate the performance of the job, analyze the resource cost. The experimental results show that, in the case of heavy load, the Navie scheduling strategy to use the resources of the cloud will generate a lot of cost, while the use of request backfilling and redirection strategy based on the expansion factor to use the resources of the cloud, the cost is relatively low [2]. For the resource scheduling in the cloud, Pop proposed a resource load balancing scheduling algorithm based on trust driven. The algorithm considers the trust requirements of user tasks, takes the resource load balancing as the goal, and takes into account the time span of the task execution time and other factors. Simulation results show that the proposed algorithm can improve the load balance and reduce the relative execution time of the tasks [3]. Beghdad proposed the ant colony optimization algorithm, and is used to solve the
problem of the classical traveling salesman problem in computer [4]. Subsequently, a large number of improved ant colony optimization algorithm began to appear, and was applied to the job-shop problem, network routing problem, vehicle routing problem and other problems [5]. At present, the convergence of the algorithm is not high. Taking into account the cloud computing environment and the grid environment has a big difference, the size of the cloud is larger, and the computing power of each node is slightly lower than that of the grid site resources [6]. However, the service quality is not lower than the grid computing, so the efficient resource scheduling algorithm is the key to improve the performance of the cloud computing [7].

2 Ant colony algorithm with three constraint conditions

Ant colony optimization algorithm is a kind of swarm intelligence algorithm, which simulates the process of ant foraging [8, 9].

In this paper, the update strategy of pheromone is adopted as follows:

$$\Delta \nu_j(t) = \begin{cases} R & \text{across}(i, j) \\ D_i & \text{not across}(i, j) \end{cases}$$

In the formula, $R$ represents the pheromone intensity, which affects the convergence rate of the algorithm to a certain extent, and $D_i$ indicates the total length of the path of the ant $i$ in the cycle.

When looking for a suitable computing node, first, it starts from the node to calculate its own resources. If the remaining resources are sufficient to meet the amount of jobs submitted by the user, then priority in the allocation of their own resources. If the resource is not enough to calculate the minimum amount of resources allocated to the user, then according to the search algorithm starts searching for other suitable cloud computing resources. The Ant colony optimization allocation algorithm proposed in this paper is realized in this part. In order to avoid stagnation search, the search will be carried out within a certain range, the purpose is to reduce the algorithm itself brings network overhead. If there is still no appropriate resources in all of the sub nodes, then the node report to ask for instructions to the main scheduling node removed user data mirroring the nodes in the cluster partition.

The slave node domain as an undirected graph $G(V, E)$, in which $V$ is the set of all slave nodes in regional Area, $E$ is the network set which connecte to each slave node. In the cloud computing network, it is divided into several sub regions, and then the same number of ants are assigned to each region. Each group of ants search only in their own region to find a suitable computing node, that is, in the $E$ to find an optimal path. The following parameters should be considered in the metric:

1. Expect the execution time, $ET(f)$ refers to the path of $f$ at the end of the computing resources to cope with this job takes time;
(2) Network latency: \( ND(f) \) refers to the maximum network delay generated by path \( f \).

(3) Network bandwidth: \( BW(f) \) refers to the maximum bandwidth provided by the path \( f \).

Assuming the feature set of a virtual machine resource \( VM_i \) is:

\[
V_i = \{v_{i1}, v_{i2}, v_{i3}\}
\]

In the formula, \( v_{i1} \) is the CPU feature, \( x_{i2} \) is the memory feature, \( x_{i3} \) is the bandwidth feature.

User demand for the diversity of cloud computing resources and preferences, how to make the QoS guarantee. QoS description of the task can usually be used to complete the task of time, memory, network bandwidth and other parameters to quantify the QoS. For example, task completion time QoS as the evaluation criteria, it include the start time of the task, the completion time, the end time, etc., can be selected to complete the task of all time as the evaluation index.

Usually the general expectation vector of the class \( i \) task can be described as:

\[
X_i = \{x_{i1}, x_{i2}, x_{i3}\}
\]

In the formula, \( v_{i1} \) is the CPU feature, \( x_{i2} \) is the memory feature, \( x_{i3} \) is the bandwidth feature and at the same time to meet: \( \sum_{j=1}^{3} x_{ij} = 1 \).

The constraint function for resource selection is:

\[
Y(x) = \frac{\alpha ET(f) + \gamma ND(f)}{\beta BW(f)}
\]

\[
x \text{ s.t. } \begin{cases} ET(f) < T_1 \\ BW(f) > T_2 \\ ND(f) < T_3 \end{cases}
\]

Ultimately, the process of determining the target resource and path is the process of finding the shortest path and the path and the resource of \( Y(x) \). \( \alpha, \beta, \gamma \) are the weight of three constraint conditions. \( T_1, T_2, T_3 \) are the boundary constraints, which meet the QoS constraints in cloud computing environment.
3 Experiment result and analysis

CloudSim provides a data center based virtual technology, modeling and simulation capabilities and resource monitoring, host to virtual machine mapping capabilities. The configuration of the experiment as follows: the main frequency 2.0GHz of the dual core CPU, the size of the 8GB memory, 500GB hard drive, Windows7.0 operating system.

According to the ant colony algorithm and scheduling work flow, in this experiment, we set the number of tasks from 40 to 200, and the number of nodes is 8. In order to show the difference, we have to set the node's QoS property gap larger, mainly including CPU, memory and network bandwidth. At the same time, select the traditional ant colony algorithm and three constrained conditions ant colony algorithm is proposed in this paper, in order to form a comparison on the experimental results. The two algorithms are executed 5 times and the average value is taken. The time spent by the task execution is shown in Figure 1.

![Comparison of the execution time of the two algorithms](image)

Fig. 1. Comparison of the execution time of the two algorithms

From the graph, we can see that the three constraint conditions of ant colony algorithm, its execution time is significantly lower than the traditional ant colony algorithm in the implementation of cloud computing resource scheduling. In addition, with the increase of the amount of the task, the advantage of this kind of speed is more obvious.

4 Conclusions

In this paper, based on the ant colony algorithm, a kind of ant colony algorithm based on three constraint conditions is constructed, which is used for resource scheduling in cloud computing. Experimental results show that the proposed method has faster
execution speed than the traditional ant colony algorithm, and the load balancing of the results is more satisfactory.

References