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Research on Task Scheduling Algorithm Based on Trust in Cloud Computing

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Abstract

Cloud computing is regarded as a new computing mode in recent years, and has been widely applied. Its task scheduling affects the performance of the cloud computing system directly, and people pay more and more attention to the security problems of cloud computing. The paper introduces the trust in scheduling algorithm, improves and fuses the PSO and SA in order to make them complementary. By applying that to the task scheduling strategy of cloud computing, we can get a higher scheduling efficiency. We implement the proposed algorithm and verify its high efficiency through the simulation platform (CloudSim).

Keywords*: Cloud computing; Scheduling algorithm; Trust; Simulated Annealing algorithm*

1. Introduction

Cloud computing is the evolution and development of parallel computing, distributed computing and grid computing technology. As a kind of new network service, it has been developed rapidly in recent years.

Task scheduling strategy plays an important role in the performance of the cloud computing system.

Because the task scheduling problem of cloud computing has a certain with the traditional distributed, most of the existing cloud computing task scheduling strategies are based on the traditional distributed environment, or improve the task scheduling method, which has some limitations [1]; QoS requirements of user task scheduling are different, the number of task and the size of resources are huge, so the task scheduling problem is very complex. How to make a reasonable distribution of cloud computing resources and efficient scheduling of a large number of application tasks is the main content of the task scheduling, but also the main problem of cloud computing. Therefore, in recent years, the cloud computing task scheduling problem has attracted a large number of experts and scholars and technical personnel to conduct a in-depth research [2]. A Max-D scheduling algorithm is proposed in paper [3] which is based on the shortage of the traditional Min-Min algorithm in load balancing and the average completion time of jobs. A trust driven virtual machine resource scheduling algorithm is proposed in paper [4], which assigns the task to the highest trust value of the virtual machine. The introduction of trust mechanism, can significantly improve the success rate of the task and virtual machine transactions, reduce the probability of malicious attacks mission. Paper [5] proposed an energy-aware and trust-driven virtual machine scheduling TD energy-aware-Opt algorithm adapting to cloud computing data centers. To a certain extent these models and algorithms have

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improved the security of the algorithm, but there are also some disadvantages. In this paper, the trust mechanism is introduced into the scheduling of cloud computing, and combined with the characteristics of the particle swarm simulated annealing algorithm which is not easy to fall into the local optimum, all these can improve the efficiency of cloud computing scheduling.

2. Problem Description

2.1. Cloud Task Scheduling Model

There are many resource in the cloud, cloud computing system ensure the resource utilization, at the same time provide the high quality service for the user as far as possible. However, the cloud computing system has limited resources. There is a phenomenon of resource competition, and the different tasks have different demands on the resources, which can only use the resource scheduling algorithm to allocate the tasks reasonably. Cloud computing platform task scheduling model is shown in Figure 1:

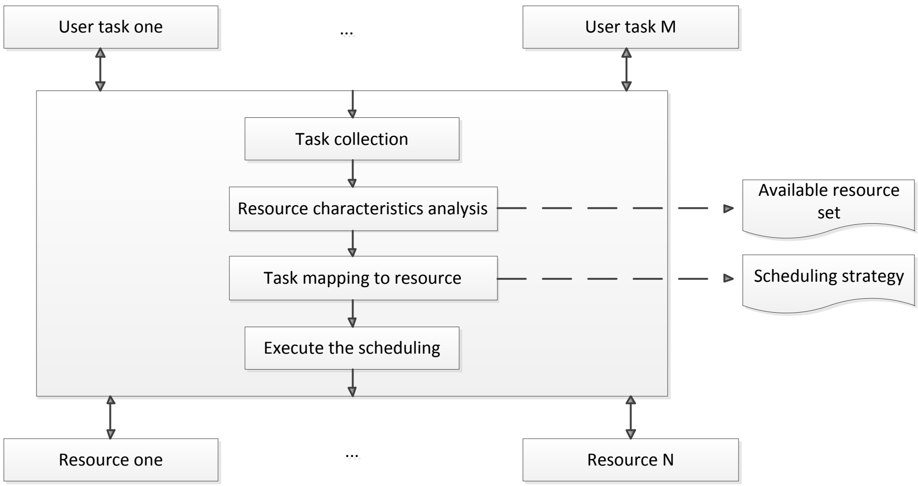

Figure 1. Task Scheduling Model of Cloud Computing

The trust mechanism is introduced into the cloud task scheduling process, and strives to achieve good trust in the scheduling process. The specific scheduling process is as follows:

a. The user submits tasks to the task queue;
b. The resources available which meet the requirements is fed back to the scheduling center according to the trust relationship;
c. Cloud scheduling center of the resource uses particle swarm simulated annealing algorithm which meet the conditions to find the best resources;
d. Finally the scheduling center carries out the task scheduling.

2.2. The Trust Mechanism

Trust is a complicated subjective concept, which usually relates to the reliability, honesty and computing power of the entity. At present, there is not a universally accepted definition in the academic field. In this paper, we use the definition of paper [6]: trust is the assessment of the credibility of an entity behavior, it gets the entity desire by the observation of past actions of entities and other entities' recommendation. Trust degree is used to represent the level of trust.

Trust degree refers to the trust level that a node can complete its expected task, is a measure of the trust relationship. The trust degree of a node discussed in this paper refers to the level of trust in computing services provided by a resource node in a given time period. This level of trust is dynamic, the value of trust changes between 0 and 1.

Trust in trust relationship includes direct trust and indirect trust. Direct trust refers to the trust relationship between two nodes with direct connection in cloud computing, it can be expressed as [7]:

$$Direct\_T(i,j) = (\sum_{k=1}^{N} \omega_k p_k^{(i,j)})(1-\rho(i,j)) \tag{1}$$

Among them: N represents the number of resource nodes that need to be considered; the weight of the node is represented by the ωi; ρ(i, j) represents failure rate from the node i to node j, the initial value of ρ(i, j) is 0; p(i, j)k is the comparison relationship value between node i and node j, this is, (if the computing power of node i is greater than the computing power of the node j, p(i, j)k = 0;if the computing power of node i is equal to the computing power of the node j, p(i, j)k = 1; if the computing power of node i is less than the computing power of the node P, then p(i, j)k = 3).

Indirect trust refers to the trust relationship between the two nodes which establish the relationship between cloud computing through the third party. The indirect trust relationship value between the two nodes can be expressed as follows:

$$Indirectirect\_T(i,j) = \sum_{k=1,k\neq i,j}^{N} (\beta_{(i,k)} \times Direct\_T(k,j)) \tag{2}$$

Where M is the number of cloud computing trust domain; $\beta_{(i,k)}$ is the evaluation value between node i and node k; $\sum \beta_{(i,k)}$ =1, the initial value of $\beta_{(i,k)}$ =1/m, it changes with the cloud environment.

In summary, the comprehensive trust degree between node i,j can be expressed as follows:

$$Trust(i,j) = \alpha \times Direct\_T(i,j) + \beta \times Indirectirect\_T(i,j) \tag{3}$$

α,β respectively expressed the weights of direct trust value and indirect trust value, α+β =1 and values are all in the [0,1].

3. The PSO-SA Algorithm

3.1. Particle Swarm Optimization Algorithm

Particle Swarm Optimization (PSO) was proposed by Kennedy and Eberhart in 1995[8], it is a random searching algorithm based on colony cooperation, and developed by foraging act of research and observation about groups of birds. In algorithm, each optimization problems was regarded as a particle in n-dimension space searching, each particle gradually move to the better place in the region according its fitness, and finally we get the global optimal solution.

$$\mathrm{v}_{i,j}(t+1) = \omega \mathrm{v}_{i,j}(t) + c_1 rand_1()(p_{i,j}(t) - x_{i,j}(t)) + c_2 rand_2()(p_{g,j}(t) - x_{i,j}(t)) \tag{4}$$

Where $X_i=(x_{i,1},x_{i,2},\ldots,x_{i,n})$ and $V_i=(v_{i,1},v_{i,2},\ldots v_{i,n})$ respectively denote the particle i's current location and flying speed, t denotes iterations, $P_{i(t)}=(p_{i,1(t)}, p_{i,2(t)}, \ldots,p_{i,n(t)})$ and $P_{g(t)}=(p_{g,1(t)}, p_{g,2(t)}, \ldots,p_{g,n(t)})$ respectively denote the particle i's the best position in history and current, the later also called the best global location, c1 and c2 denote the learning factor, rand1() and rand2() denote two random independent numbers in [0,1].

3.2. Second-Order Headings Simulated Annealing Algorithm

Simulated Annealing (SA) is a global optimal algorithm in theory. It selects the target, which is relatively small, in neighborhood with a certain probability. SA is stem from the simulation of annealing process in thermodynamics. In a preset initial temperature, SA can get an approximate optimization solution in polynomial time by the means of decreasing the temperature parameters tardily.

Under a certain controlled parameter T (Temperature), the current solution i, and the corresponding objective function is E(i); the new solution j in neighborhood and its corresponding objective function is E(j). SA accept the new solution j through the Metropolis criterion, it is described below[9].

If E(j)<E(i), or while E(j)>E(i) and where rand(0,1) denotes a random even-distributed numbers in (0,1), j will replace i to be the current solution. In other conditions, i is still the current solution.

Temperature was controlled by refrigeration progress chart, and will decrease to 0 from high to low. It also can give an initial value T0, attenuation function that is annealing function: Tk+1=Tk*r, r∈(0.95,0.99), where the greater value of r, the slower of the temperature decreased, and its final value is T_f.

3.3. The Fusion of PSO and SA Algorithm

The basic idea of PSO-SA Algorithm is utilizing the fast search capability of PSO in order to get a better group firstly, that is select q locally optimal solutions and form a set P_i, $P_i=\{P_1,P_2,\ldots,P_q\}$. Then, the q selected solutions form a new group, and it utilizing the jump ability of SA to optimize the partial better individuals. It can avoid PSO involving local extremum, and make the solve efficiency and QoS more ideal.

The objective of task scheduling in cloud environment is to achieve optimal scheduling of tasks submitted by users, and to enhance the trust between resources and tasks. Therefore, the objective function is:

$$f(X) = Trust(i,j) / Timespan(X) \tag{5}$$

Among them, Timespan (X) represents the time span, the execution time that the resource i assigned to the task j.

Select the optimal solution Xbest with the principle of simulated annealing: Calculate the objective function f (P_i) and f (P_{i+1}). If $\triangle f=f(P_{i+1})- f(P_i)<0$, P_{i+1} replaces P_i , that is, eliminate the local optimal solution P_i , otherelse exp(-△f/Tk) =pr , pr >rand(0,1) , P_i replaces P_{i+1}, otherwise it will retain P_i elimination P_{i+1}. Until the $T_k \approx T_f$, get the optimal solution of P_k population that is the optimal solution of X_{best}. That f () is the objective function.

The flow chart of PSO-SA algorithm is:

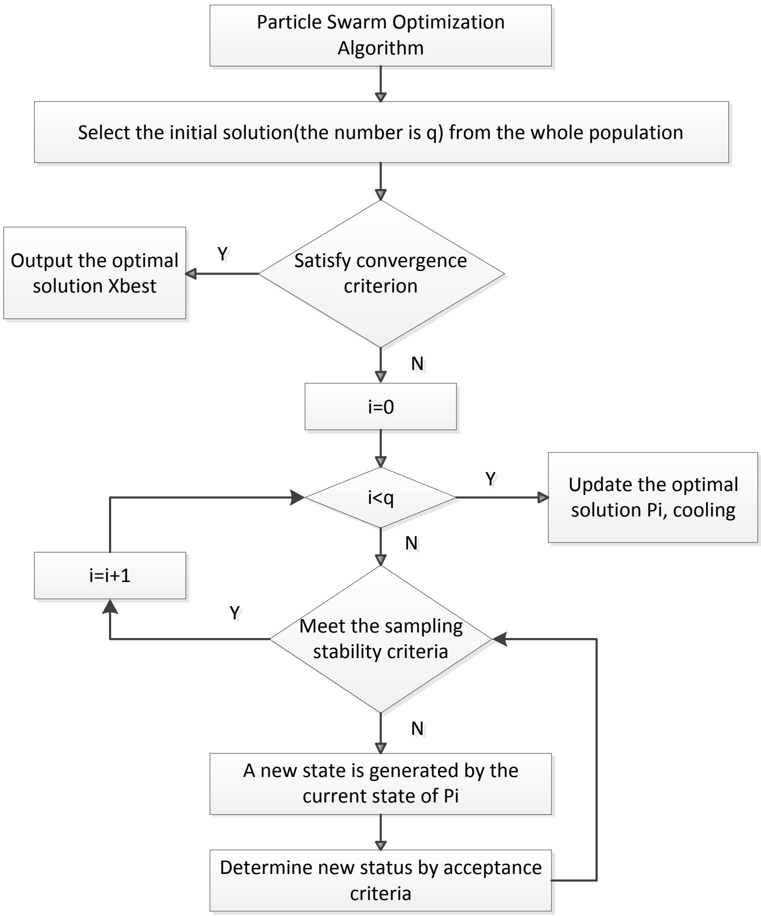

Figure 2. The Flow Chart of PSO-SA Algorithm

4. The Experimental Simulation and Result Analysis

This paper uses Java as the simulation language, CloudSim [10-11] as the simulation platform to carry out the simulation experiment. System environment of simulation experiment: CPU: dual core 2.50GHz, HD: 500G, Memory: 6G. The simulation parameters: 150 virtual nodes; the number of tasks: 100-600. The PSO-SA algorithm parameters: the starting temperature of T0=200℃, end temperature is Tf=1.0℃, annealing coefficient k=0.950, c1=c2=2, ω =1.2, global iteration algorithm is 500. Simulation experiments compare the task execution time and task incomplete rate of PSO-SA algorithm, genetic algorithm and TDMin-Min algorithm. Experimental results are shown in Figure 3 and Figure 4:

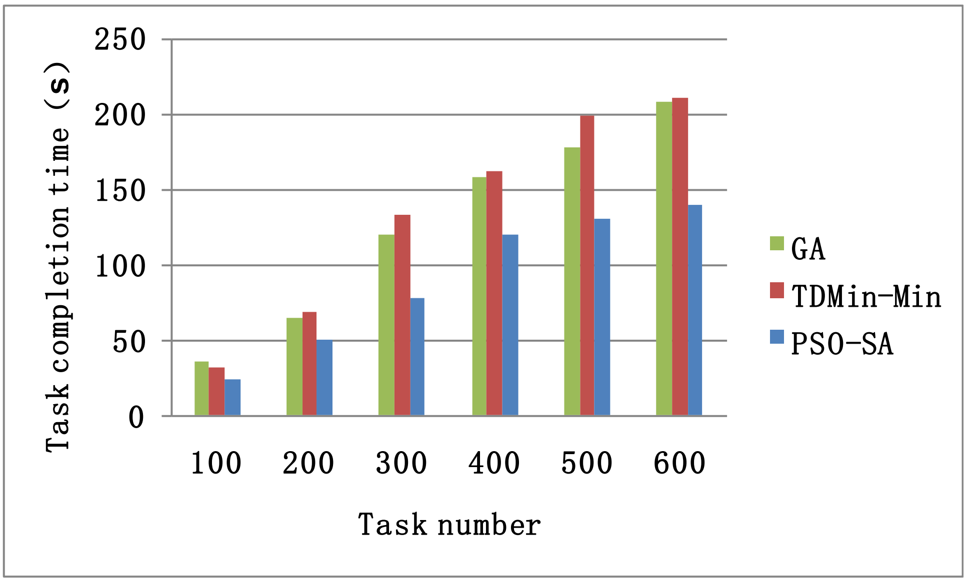

Figure 3. Task Completion Time Contrast

As is shown in Figure 3, the completion time of the PSO-SA algorithm is better than the other two algorithms with the increase of the task number, especially when the task number is 300. In GA algorithm, the minimum length is its only goal and it doesn't consider the whole performance. TDMin-Min scheduling algorithm always assigns the first task to the node which meets the requirements.

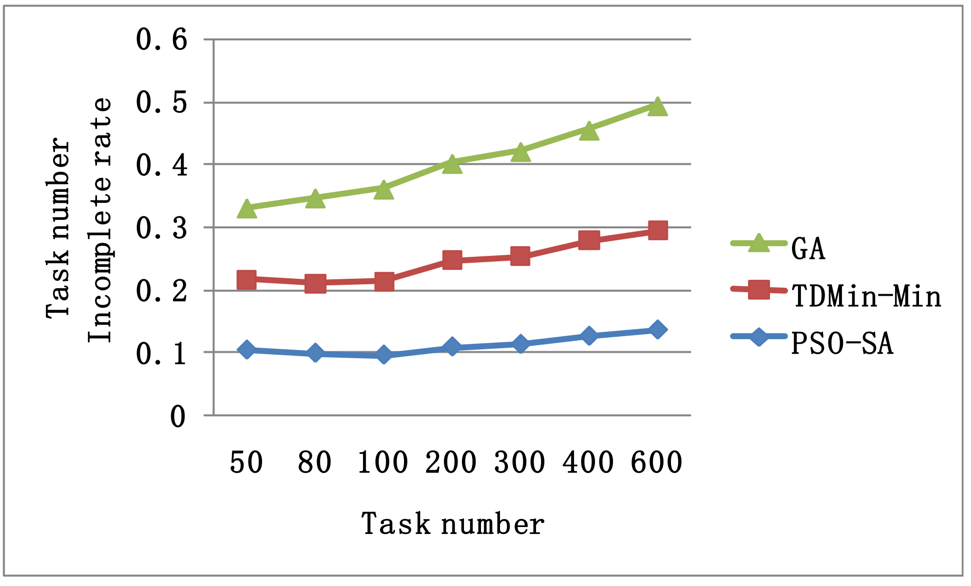

Figure 4. Task Completion Rate Contrast

Figure 4 shows the incompletion rate of the task of the three algorithms. From the graph, we can see that the PSO-SA algorithm has low incompletion rate, and the performance is better than the other two algorithms at the beginning, which improves the utilization of the resource.

In summary, from the point of view of the experimental results, the task completion time PSO-SA algorithm was shortened compared with the other two algorithms. So the algorithm of this paper improves the resource utilization of the cloud computing system.

5. Conclusion

In order to solve the problem of slow speed and easy to fall into local optimal solution of PSO in large-scale cloud task scheduling, a task scheduling strategy based on particle swarm simulated annealing algorithm is proposed, and the trust mechanism is introduced into the scheduling algorithm in order to improve the security of the task scheduling. Simulation results show that the proposed algorithm can reduce the total task completion time while satisfying users' requirements and is an effective scheduling algorithm in the cloud computing platform.

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