Chapter 11
Adaptive Ant Colony Algorithm Researching in Cloud Computing Routing Resource Scheduling

Zhi-gao Chen

Abstract Cloud computing has been regarded as one of the most important planning projects in the future, the technique will be beneficial to thousands enterprises in our country. The advantages of Cloud service depend on efficient, fast running network conditions. At present, under the condition of limited bandwidth in our country, studying fast and efficient routing mechanism is necessary, according to which Scheduling resource with the maximum capacity of a network node. Therefore, in this paper, the parameters of network capacity was increased as the threshold in each node to route adaptively, the shortest path can be found quickly on the traditional ant algorithm, and also the network capacity of nodes on the path can be adjusted accordingly. As the experimental result shown, the congestion of data on the critical path can effectively avoid by this method.

Keywords Ant colony algorithm · Cloud computing · Pheromone

11.1 Introduction

Cloud computing is a distributed processing, parallel processing and grid computing, that is stored in the PC, mobile phones and other devices on the wealth of information and processor resources are concentrated together collaborative work, great the expansion of IT capacity, a calculation method to provide services to external customers (Asterisk 2010). In 2011, cloud computing has been treated as the key project in the twelfth five-year plan by our government, the importance and significance have no question count (Xue Jiang 2010). At present, our country is in the growth stage of cloud computing (Han Bing 2010), over the next 10 years,

Z. Chen (✉)
Hu Nan vocational institute of science and technology,
Changsha, China
e-mail: Chenzhigao7621414@163.com

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many IT enterprise and the small and medium-sized enterprises will share hundreds of billions of dollars of “cloud computing cake” in the future of our country (Nezamabadi-pour et al. 2006).

While there are some disadvantages in the cloud computing industry of our country. Cloud computing needs to run in high-speed network to exert its advantages (Satyanarayanan 2001), although China has been used widely the broadband technology, but net is still less than other countries. Cloud computing needs to run in high-speed network to play its advantages, Broadband technology has been applied in our country widely, but the speed of the network is still lower than other countries. It is the premise of cloud computing construction in china that Operation cloud services needs a set of efficient and secure routing mechanism on Cloud Computing to achieve efficient resource scheduling and storage, on the basis of limited bandwidth; on the other hand, along with the expansion of cloud computing network and increase of cloud services, higher requirements are put forward to our existing network bandwidth and the resource scheduling, therefore, the research and application of the cloud computation efficient routing mechanism can improve the efficiency of routing and scheduling speed resources, as a result the cloud service will run more efficiently in the existing network infrastructure and improving fully on the return rate of investment on cloud computing infrastructure, Reference and basis of China’s construction of cloud services platform is provided better, the significant on the progress of our society and the pulling and development of national industry is greatly.

11.2 Cloud Computing Infrastructure and Ant Algorithm

11.2.1 Introduced Cloud Computing Environment

At present, cloud computing infrastructure technology is mainly the Google non open source system of GFS and hadoop technology for GFS open source implementation of the HDFS (Fetterly et al. 2010). Hadoop is a reliable, efficient, scalable software framework, and can handle large amounts of distribution data. It can make use of cluster technology processing PB data in the cheap personal computer with parallel manner, and can be used freely because of its own JAVA language framework (Asterisk 2010). The core part of Hadoop HDFS and Map Reduce use Master/slave structure, the Hadoop system is unified into the two layer structure. A HDFS cluster consists of a Name Node and a plurality of Data Node. Name Node is the main server, responsible for the management of the file system name space and client access to files, Data node is the slave server, which distributed on each physical node in a cluster usually, responsible for memory management on their physical nodes. In the internal node, files are usually divided into one or more blocks of data the blocks of data stored in a set of Data Node (IP Multimedia Subsystem (IMS) 2009). Name Node execution operation about the file system name space, such as open, closed, the rename operation, and also decided to map data block from Name Node to Data Node. Data Node is responsible for processing of read and write requests of customers, also performs a data block in accordance with the Name Node instruction.

11.2.2 Ant Algorithm

The ant algorithm (Ant Colony Algorithm) is proposed by the Italian scholar Marco Dorigo in 1992, a parallel and efficient evolutionary algorithm (Guo et al. 2010). The algorithm is a probabilistic technique for the simulation of ant foraging process in nature which is formed to find the optimal path in the graph, the core idea is: ants will left a "pheromone" chemical substances in the path searching for food (Hayden 2009), these "pheromone" can provide heuristic information where selected on walking routes, for the follow-up ants to find food as the constant updating of pheromone, optimal path can be found from the nest to the food in a relatively short period of time. The algorithm has the advantages of high parallel, convergence speed, and has Gained some satisfactory experimental results, in the traveling salesman problem, routing and scheduling problems, but the standard ant algorithm is easy to fall into local optimal solution. Considering the cloud computing environment is large in scale, and the quality of service requirements, to achieve efficient resource scheduling, the shortest path should be found in algorithm and also meet the bandwidth requirements of which cloud services supplied in the path each node can offer. The proposed adaptive ant algorithm, is based on running a cloud service according to our country current limited bandwidth, by setting the appropriate threshold about minimum network capacity to adaptively adjust searching for the shortest path, can both quickly discover the resource such as the routing, but also to improve the convergence of the algorithm, and the QOS.

11.2.3 Adaptive Ant Algorithm

To achieve efficient and fast scheduling of cloud services, in a real environment must fulfill two conditions: (1) the data transmission path must be the shortest path to reduce the data transmission distance; (2) the shortest path through each node must have enough bandwidth to run cloud services, it will be congestion in some nodes. The ant algorithm selects the shortest path by the rapid convergence condition (1) easy to implement. Search the shortest path, all cloud services are run from the path, is bound to be caused by data traffic increased sharply on the shortest path. At present, limited the basis of bandwidth in our country that can be provided by the between of each node network the maximum capacity of is has been spotty. Once all the business on the shortest path on the transmission, will make some smaller capacity network node to enter the congestion in advance. If you cannot adjust in a timely manner will make a follow-up business to continue to transfer from the shortest path, leading to congestion and data retransmission exacerbate transmission of cloud services is very unfavorable. The establishment of a multi-road by the table for the same source knot point to the target knot point. Search idea is that the network capacity threshold set automatically when preferred shortest path congestion routing, get a new "sub-optimal" shortest path. And so on, so as to achieve the normal operation of the entire network in the state of optimal network capacity. Therefore construct adaptive ant algorithm steps are: solving the source node to destination node point shortest path process, consider the capacity constraints and flow changes on the network each path in real time, i.e., solving the shortest path to the source node to destination node sections capacity minus the minimum link capacity. When the data was transferred on the shortest path close to the minimum link capacity, the bottle neck sections of congestion, the other nodes in which sections of the available network capacity bottleneck link capacity minus the capacity of the original node, rather than the capacity of the shortest path remains unchanged.

11.3 Model Designing for Adaptive Ant Algorithm

Firstly, each node in the cloud environment was treated as the point in the map abstractly. A certain node was set as the start point, will was searched by the ant as the "food" finally, namely to complete the routing process.

11.3.1 Improvement of Algorithm

Firstly, each node in the cloud environment is abstracted as a connected graph point to determine a node as a starting point, the final node of the visit as "food" by the ants to search. Routing process was completed when the ants had found the target in the traditional ant algorithm, the filmon was reserved in line which the ants searched, the algorithm has been modified in this paper that the filmon was reserved on each node traversed by the ants. The τi represents the amount of information, H represents the network capacity values the node can carry, Threshold is set to di, if di > H, hosted by the node network traffic has exceeded the network capacity, this means that the congestion would be coming on the node, then the new business transmission can not be longer allowed in the path. The choice of the new path must be started in order to bypass the sections in upcoming congestion, a new sub-optimal path would be created.

With the establishment and the end of the network session, the amount of information on each node would change when each cycle completed, the Fireman on each node Adjusted as (11.1, 11.2):

$$\tau_i(t+1) = \rho\tau_i(t) + \Delta\tau_i \tag{11.1}$$

$$\Delta\tau_i = \sum_{k=1}^{m\times n} \Delta\tau_i^{\mathrm{k}} \tag{11.2}$$

Among them, the k-th ant in the cycle stays in the pixels on the filmon.

11.3.2 Experiment

Figure 11.1 is a simulation example of a network of choice in this article, a total of 24 nodes in the graph, the connection on behalf of the node between the node path, the connection of a group of figures, respectively, the distance between the node and the maximum network capacity, it is assumed from the source node 1 to node 23, and the source node to node 24, two paths through the data routing experiment.

Step1: designed to be adaptive ant algorithm to find the shortest path to node 1 → 23;here to take $\alpha = 1$, $\beta = 2$, $\rho = 0.8$, Q = 1000, the initial value τmin = 60. Get 1 → 23 of the shortest path is ①: 1 → 3 → 6 → 11 → 16 → 20 → 23, 15 flow (minimum segment capacity) is 4;

Step2: the capacity of each segment of the shortest path 1 minus the smallest segment of the shortest path capacity, the results of 16 → 20 segment of the capacity is 0, the segment identified as the bottleneck segment, the segment most prone to congestion;

Step3: According to the capacity change and the connection matrix changes to look for the source node and destination node 23 the shortest path available to the

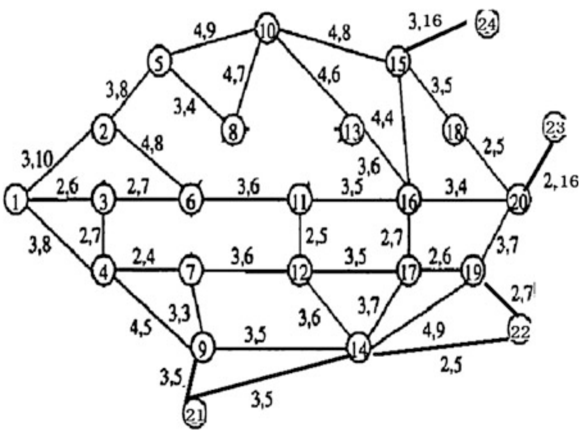

Fig. 11.1 Node topology

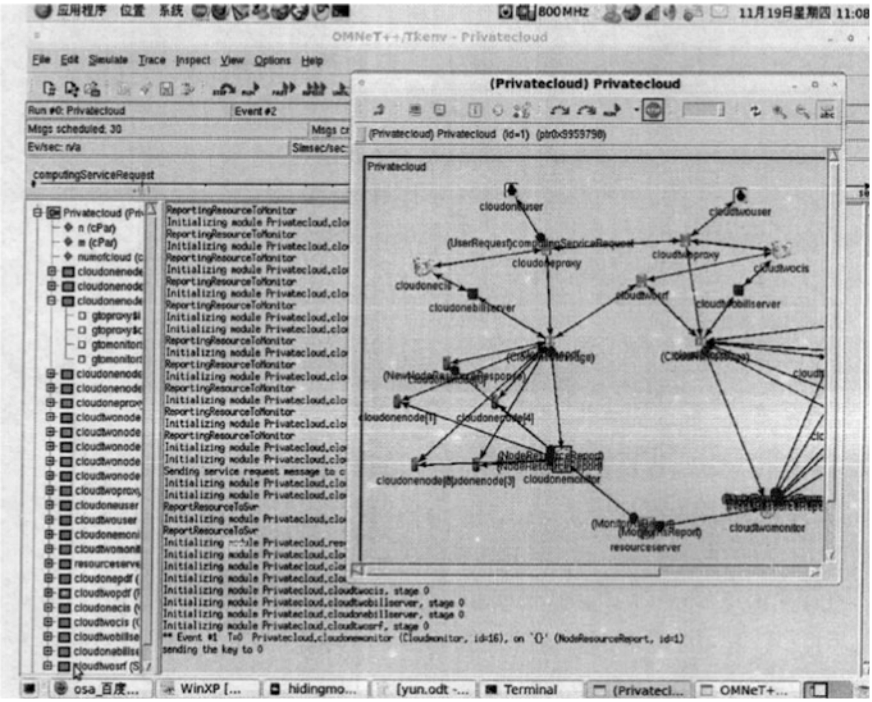

Fig. 11.2 Cloud node topology

new shortest path ②: 1 → 4 → 7 → 12 → 17 → 19 → 20 → 23, 18 flow rate, and similarly the capacity of each segment of the shortest path ② subtract the smallest segment of the shortest path capacity, the result of the capacity of the 4 → 7 segment 0, that segment is identified as unavailable, repeat the same steps to find the shortest path ③ change Network: 1 → 4 → 9 → 14 → 19 → 20 → 23, length 19, flow rate of 3; ④: 1 → 2 → 5 → 10 → 15 → 18 → 20 → 23, length 21, flow rate of 5;

Step4: could not find a feasible route of the destination node of a source node → (or less than the number of shortest path to the default limit), the source node or destination node will become an isolated point, out of the end of the loop (Fig. 11.2);

Step5: will find the shortest path sequence as the source node 1 → purpose node 23 optional routing tables, the same method can be found in the 9 → 15 optional routing tables. As the experiment shows, the adaptive ant algorithm constructed in this paper had got the data listed in Table 11.1. As the experimental results, dynamic optimal routings from node 1 → 23 and 9 → 24, there are four paths of Optimal routing from node 1 → 23, and four paths of Optimal routing from 9 → 24 as the same. According to the provisions of the preferential routing priority, in order to achieve a dynamic optimal routing because of the network congestion or partial failure.

Table 11.1 Dynamic optimal routing

	Source → target order selected path	Shortest path	Flow
1 → 23	1 → 23 1 1 → 3→6 → 11 → 16 → 20 → 23 2	15	4
	1 → 4→7 → 12 → 17 → 19 → 20 → 23	18	4
	3 1 → 4→9 → 14 → 19 → 20 → 23	19	3
	4 1 → 2→5 → 10 → 18 → 20 → 23	21	5
9 → 24	9 → 24 1 9 → 14 → 17 → 16 → 15 → 24	15	4
	2 9 → 14 → 19 → 20 → 18 → 15 → 24	18	1
	3 9 → 7→6 → 8→10 → 15 → 24	19	3
	4 9 → 4→3 → 2→5 → 10 → 15 → 24	21	5

11.4 Discussion

In this paper, the adaptive ant algorithm can effectively avoid congestion in network on the shortest paths, and select the shortest paths automatic by setting the minimum network capacity threshold for each of the segments in the shortest path in hadoop cloud platform, provided a choice of an adaptive routing scheme in a cloud environment.

The experiments about the algorithm are carried out in hadoop cloud platform, not by simulator, the practicality and adaptability is better. A good self-healing method was provided for some sections on the shortest path when some sections were failed, for author/s of more than two affiliations: to change the default, adjust the template as follows.

The minimum network capacity as the only one factor which was considered in this method when the paths were selected adaptively on each segment, this is certainly not enough in the real cloud environment, therefore, the algorithm needs the further improvement if been applied in the cloud environment.

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