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Research on Application of Cuckoo Algorithm with Limited Scope to Compose Cloud Services

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Abstract:- In recent years, enterprises put their products as services to the Internet, but users are not satisfied with a single cloud service. This paper proposes a cloud service composition based on limited range a cuckoo algorithm, aiming to help users choose a high-performance and low-cost cloud service composition according to QoS. Compared with the cuckoo algorithm and other optimization algorithms, the proposed algorithm has better optimization results.

Keywords:- *QoS; Cloud Service Composition; Cuckoo Algorithm.*

I. INTRODUCTION

Cloud computing has a ability to access data and services remotely. Many organizations publish resources as services for client to choose and use. How to choose high-performance service composition for users among many cloud services has been a research hotspot. However, the service composition is a NP (Non-deterministic Polynomial) problem. To solve the problem, this paper proposes an improved cuckoo algorithm based on the limited range. It selects limited services as the search range through the roulette method to improve the optimization ability.

The rest of this paper is structured as follows: Section 2 introduces the related work; Section 3 introduces the background knowledge; Section 4 introduces the improved cuckoo algorithm to find the cloud service composition scheme; Section 5 shows the experiment and its results; Section 6 summarizes the work of this paper.

II. RELATED WORK

In research [1], a triangular fuzzy genetic algorithm which based on fuzzy theory and genetic algorithm is proposed to solve the quality of service (QoS) composition problem. When the service scale is large, the algorithm has a strong search ability. Research [2] proposes a hybrid method for efficient service composition in cloud computing. By identifying QoS parameters, a particle swarm optimization algorithm is used to select the optimal service based on the fitness function. Research [3] proposes a method to solve the service composition problem by combining global optimization selection strategy and local optimization selection strategy with greedy algorithm. In research [4], a hybrid algorithm combining Drosophila algorithm and genetic algorithm is proposed. Experiments show that the final result is higher than the original Drosophila algorithm.

III. BACKGROUND KNOWLEDGE

Related concepts

Definition 1: cloud service (*CS*) refers to the virtual resources that users can obtain through the Internet in an on-demand and easy to access way. It can be represented by triple {*ID, F, Q*}, where *ID* is the unique identification of a cloud service, *F* is the functional attribute of the service, and *Q* is a set of non-functional attributes of the service, that is, QoS. The non-functional QoS determines the quality of service. This paper selects response time and cost as the QoS standards of service.

Response time (*T*): the time required from the user submitting the service request to obtaining the execution result of the cloud service.

Cost (*C*): the cost for users to obtain cloud services.

Because the measurement of QoS attribute are different, QoS attribute needs to be normalized. In this paper, each QoS attribute is transformed into a value between 0-1. The larger the normalized value is, the better the quality of service is. The normalization formula is as follows:

$$Q_{ij}' = \begin{cases} (Q_j^{\max} - Q_{ij}) / (Q_j^{\max} - Q_j^{\min}) & Q_j^{\max} \neq Q_j^{\min} \\ 1 & Q_j^{\max} = Q_j^{\min} \end{cases} \quad (1)$$

In this formula, $Q_j^{\max}$ and $Q_j^{\min}$ represent the maximum and minimum values of the *j*-th QoS attribute, and Q_{ij} is the *j*-th QoS value of the *i*-th service. The higher the normalized QoS value, the higher the quality. For response time (*T*) and cost (*C*), normalization is performed by using formula (1).

Cloud service composition based on QoS

Definition 2: Cloud service class (*CSF*) is a collection of cloud services with the same functional attributes.

Definition 3: Cloud service composition (*CSC*) is a series of simple cloud services from different cloud service classes. It is recorded as $CSC = \{CS_1, CS_2, \ldots, CS_n\}$, where *n* is the number of cloud service classes. The QoS calculation method of *CSC* is as follows:

$$T = \sum_{i=1}^{n} T(CS_i) \qquad \text{Formula (2)}$$

$$C = \sum_{i=1}^{n} C(CS_i) \qquad \text{Formula (3)}$$

In order to evaluate the quality of the combination, a fitness function needs to be set as follows:

$$f(CSC) = T + C \qquad \text{Formula (4)}$$

IV. ALGORITHM DESIGN

The proposed method apply cuckoo algorithm [5] to limited searching range. The major algorithms are introduced.

A. Limited Search Range

Roulette is a range selection method. It takes the QoS value of each cloud service as an indicator. The higher the QoS value, the greater the probability of cloud service being selected. The steps are as follows:

(1) Calculate the QoS value of a single service in a cloud service class $f_i=T(CS_i)+C(CS_i)$, then calculate the sum of all service QoS values in the cloud service class $F = \sum_{i=1}^{j} f_i$.

(2) Calculate the probability of each cloud service being selected $p = f_i / F$.

(3) Construct a roulette for cloud service class based on probability.

(4) Generate a random number between 0-1 and rate the selected individuals according to the random array.

(5) Repeat (4) until the conditions are met to select the search range of cuckoo algorithm.

B. Cuckoo Algorithm

In the algorithm of cuckoo, cuckoo is based on Levy's random walk to find the nest. The formula of finding cuckoo's nest is:

$$x_{ij}^{n+1} = x_{ij}^{n} + \alpha \times Levy(\lambda) \qquad \text{Formula (5)}$$

Among them, x_{ij}^{n+1} and x_{ij}^{n} represent the location of class *j* service when the nest is *i* between the *n+1* and *n* generations, α is the step length, and the selected value is different under different conditions. $Levy(\lambda)$ is a probability distribution with weight, which is used to describe the process of random walk. In most studies of cuckoo algorithm, Levy flight path formula is used. The formula is as follows:

$$s = \frac{u}{|v|^{\frac{1}{\beta}}} \qquad \text{Formula (6)}$$

In cuckoo algorithm, β is 1.5, *u* and *v* are random numbers and obey normal distribution.

C. Service composition based on limited range cuckoo algorithm

The improved cuckoo algorithm starts to limit the search range of cuckoo's nest, initializes the search range of cuckoo's nest through roulette method, and makes the results more convergent. The specific steps are as follows:

Step 1: Use roulette to initialize the search range of cuckoo nest.

Step 2: Initialize *n* cuckoo nests randomly, that is, *n* service composition schemes.

Step 3: According to formula (4), the fitness of each combination scheme is calculated, and the scheme with the largest fitness function is selected as the current optimal solution.

Step 4: According to the position updating formula (5) to generate *n* new combination schemes, in which the α step value is 1. Then calculate the fitness of each combination scheme, and the optimal solution is updated by comparing with the optimal solution obtained in the previous step.

Step 5: According to the discovered probability p to update the nest randomly, and calculate the fitness of the new combination scheme. Then, the optimal solution is updated by comparing with the optimal solution obtained in the previous step.

Step 6: Determine whether the termination condition is met. If not, it returns to Step 4, otherwise it outputs the optimal solution.

V. EXPERIMENTAL RESULT

A. Experimental Environment

We run the experiment on a computer with the following configuration:

The CPU parameter is Intel(R) Core(TM)i5-7500U 3.40GHz 3.40GHz. The RAM parameter is 16.00GB DDR4-2400. The operating system is Windows 10 Professional 64-bit. The experimental platform is built in Matlab R2016b.

B. Data Set

In this experiment, the data test set randomly generated by Matlab includes 3000 cloud services, which are divided into six types of cloud services with different functional attributes. Each cloud service package expands two QoS attributes, namely response time (value range 50-200) and cost (value range 100-500). According to the formula (1), these QoS values are normalized, and the simulation test is carried out through the steps based on the limited range cuckoo algorithm. Finally, it compares with the traditional cuckoo algorithm and genetic algorithm.

C. Performance Analysis

In the experiment, we use the original cuckoo algorithm, genetic algorithm and limited range cuckoo algorithm to solve the problem of cloud service composition based on QoS. With the increase of the number of iterations, the optimization results of the three algorithms become better and better. Among them, the fitness of the traditional algorithm is slightly higher than that of the genetic

algorithm, and the improved algorithm is significantly higher than the other two algorithms.

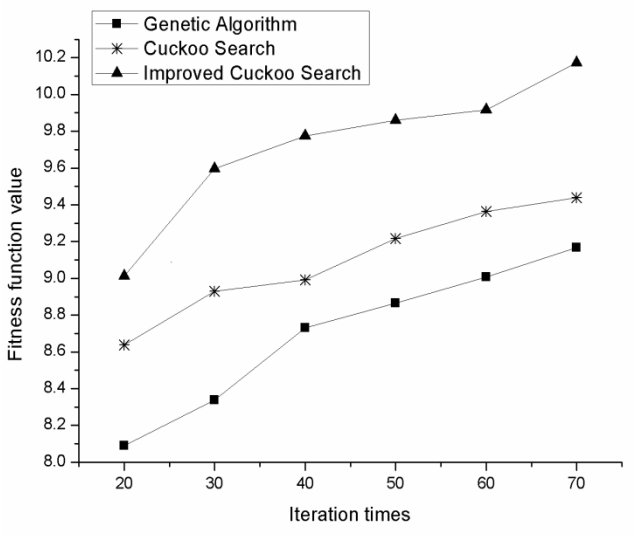

Fig 1:- Fitness Contrast

In terms of search time, as shown in Table 1, with the increase of the number of iterations, the time required is also gradually increasing. The time required by the traditional cuckoo algorithm and the genetic algorithm is almost the same, and the time required by the limited range cuckoo algorithm is higher than the other two algorithms. However, when iterating 70 times, the time required by the algorithm based on the limited range is only 0.6 seconds longer than that of the traditional algorithm, and the improved algorithm has irreplaceable advantages in the optimization ability. In a word, the improved algorithm can effectively solve the cloud service composition problem based on QoS.

Iteration times Running time(S)	Genetic algorithm	Cuckoo search	Improved cuckoo search
20	0.211	0.363	0.601
30	0.222	0.397	0.692
40	0.334	0.415	0.773
50	0.421	0.443	1.027
60	0.457	0.478	1.152
70	0.562	0.601	1.198

Table 1:- Running Time Comparison

VI. CONCLUSIONS

In this paper, the non-functional QoS of cloud service is taken as the evaluation index, and the cuckoo algorithm is used to model and solve the cloud service composition problem, and the cuckoo algorithm is further optimized by reducing the search scope, so that its convergence is higher. Compared with the traditional algorithm and genetic algorithm, the algorithm based on the limited range is better in the ability of optimization. Although the simulation experiments prove the effectiveness of the algorithm, there are some shortcomings, such as only considering the global QoS constraints, not considering the user preferences for certain attributes to make service selection. In the future work, we will consider applying data mining and machine algorithms to cloud service composition according to user preferences.

REFERENCES

[1]. J. Xu, L. Guo, R. Zhang, H. Hu, F. Wang, and Z. Pei, “QoS-aware Service Composition Using Fuzzy Set Theory and Genetic Algorith.” Wireless Personal Communications v102 olume, pp: 1009–1028. 2018.

[2]. A. Naseri, And N. Jafari Navimipour, “A new agent-based method for QoS-aware cloud service composition using particle swarm optimization algorithm.” J Ambient Intell Human Comput 10, 1851–1864, 2019.

[3]. M. Alrifai, T. Risse, W. Nejdj, “A hybrid approach for efficient Web service composition with end-to-end QoS constraints.” ACM Transactions on the Web (TWEB), Article No.: 7, 2012

[4]. F. Seghir, A. Khababa, “A hybrid approach using genetic and fruit fly optimization algorithms for QoS-aware cloud service composition.” J Intell Manuf 29, 1773–1792, 2018.

[5]. X. Li, “Optimizing the QoS Composition Process Based on the Improved Cuckoo Search Algorithm.” Northeast Normal University, 2014.