Service Replacement Based on Service Cluster Based on Information Technology

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Abstract. With the rapid growth of service resources, how to quickly and accurately find the replaceable service is a key problem when the service fails. To solve this problem, this paper proposes a research method of service replacement based on service cluster. Some similar web Services are put in the same set. Through the optimization of function similarity and service function, the candidate set of service replacement is generated. On the basis of the candidate set, Word2Vec is used to calculate the word embedding of each cloud service. By calculating the cosine value of the word vector of two cloud services, the similarity of the service is obtained, the cloud service with high similarity is replaced with the invalid service. Experimental results show that the method is correct and effective, and improves the efficiency of service replacement to a certain extent.

Keywords: Cloud Services, Service Cluster, Service Replacement

1. Introduction
Cloud computing is a kind of distributed computing technology, it is through the network will be a huge computing processing program automatically divided into numerous smaller subroutines, and a large system composed of multiple servers. After searching, calculating and analyzing, the processing results will be returned to the user. Through this technology, network service providers can process tens of millions or even billions of information in a few seconds, and achieve the same powerful network service as "supercomputer". Cloud computing has powerful computing and storage capacity, reduces the investment cost, and can provide users with flexible, personalized, diversified and simple applications and services [1]. With the continuous maturity of cloud computing technology, many different cloud services are registered and released on various cloud platforms. Users can search and rent their expected cloud services according to their needs, which can effectively save manufacturing costs, shorten manufacturing cycle, improve enterprise production efficiency and make up for the lack of business capacity.

However, most cloud services are in a dynamic and changeable network environment, and service providers regularly update the services they provided [2]. During the execution of the constructed cloud service process, individual services may be invalid or missing. At this time, the ineffective services need to be replaced quickly; secondly, the version of cloud services will be constantly
updated with the actual needs. In the process of updating, the functions of some services may be lost, and some new services will appear. However, in order to maintain the normal operation of the service process, we need to replace the services with lost functions; In addition, the user's needs may be slightly adjusted, which also needs to replace some parts of the service [3].

The existing single service request/response mode, that is, the user's service request is bound to a web service. When the user's needs change slightly or the current response service fails due to the change of the network environment, it is necessary to find a suitable replacement service in a large number of Web services again, which costs a lot. In this paper, we propose a research method of service replacement oriented to service cluster. In order to quickly find replacement services from massive, polymorphic and virtualized cloud services for services with failure or function loss, we introduce service cluster. It can reduce the service search space and make the replacement more reasonable.

2. Service Response Architecture for Service Cluster
At present, many software is built with service-oriented architecture, which makes many small program modules into services. Because SOA is reusable, a service can be used for multiple applications and business processes after it is created. In this architecture, users can call existing applications to process the current business processes to solve new business needs. In this way, the wide application of SOA will make a large number of services appear, which will inevitably lead to the loss of services in the process of service invocation.

In view of the shortcomings of the existing single service request/response mode, this paper proposes a service request/response mode for service cluster [4, 5]. Under the traditional service response mode, a virtual resource layer is added to store the service cluster. As shown in Figure 1.

![Figure 1. Service response architecture for service cluster](image)

The service response architecture of service cluster is divided into physical resource layer, virtual resource layer and business simulation layer. Specific web services are stored in the physical resource layer, and these web services are clustered according to a certain clustering algorithm to cluster services with similar or identical functions. When a user sends out a service request, the service cluster satisfying the user's function is found in the virtual resource layer according to the service request of the business layer. Finally, the service cluster with the best quality is selected from the found service clusters and returned to the user.

3. Naming of Service Clusters
According to a certain clustering method, web services with the same or similar functions are clustered, and Word2Vec is used to train each service in the service cluster to form a word vector, then the average vector of all cloud services is calculated, and the cloud service closest to the average vector is found as the name of the service cluster [6].

3.1 Cloud Services
Cloud service [7] is a six tuple \( Cls = (N, D, I, O, Q, L) \), where

1. \( N \) is the serial number of the cloud service in the cloud service platform;
2. \( D \) is the function description of cloud service;
3. \( I \) and \( O \) are the set of input and output parameters respectively;
4. \( Q \) is a set of quality parameters;
5. \( L \) is the URL of the cloud service.

3.2 Service Cluster
The service cluster [7, 8] is a six tuple \( Sec = (N, D, I, O, S, Q) \), where

1. \( N \) is the serial number of the cloud service in the cloud service platform;
2. \( D \) is the function description of service cluster;
3. \( I \) and \( O \) are the set of input and output parameters;
4. \( S = \{cls_1, cls_2, \ldots, cls_n\} \) is the collection of all cloud services in the service cluster, where \( cls_i \) is the cloud service of \( 1 \leq i \leq n \);
5. \( Q = \{q_i\} \), \( q_i = \{u, c, [V_{\text{min}}, V_{\text{max}}], u\} \), and \( V_{\text{min}}, V_{\text{max}} \) represent the upper and lower bounds of \( q_i \).

There are \( n \) cloud services in the service cluster, namely \( S = \{cls_1, cls_2, \ldots, cls_n\} \). Word2Vec is used to train these \( n \) cloud services to form word vectors \( S_w = \{w_1, w_2, \ldots, w_n\} \).

Then the average vector of \( N \) cloud services is calculated.

\[
\overline{S_w} = \frac{w_1 + w_2 + w_3 + \ldots + w_n}{n}
\]  

(1)

The word vector and average vector of each cloud service in the service cluster are calculated for similarity, and the cloud service with the highest similarity is taken as the name of the service.

4. Discovery of Alternative Candidate Sets
Suppose \( Se \) is an invalid cloud service in the service process. In order to find the alternative candidate service set of \( Se \), we should traverse all the service clusters to find the cloud services similar to invalid cloud service in function. And then optimize the service quality through binary semantics to get the alternative candidate service set.

4.1 Functional Similarity
\( S_i \) is a cloud service, and its function description \( D = \{S_i, W_{\text{op}}, W_{\text{th}}\} \), \( W_{\text{op}} \), \( W_{\text{th}} \) represent the operation description and text description of cloud service respectively. For example, when \( i = 1, 2 \), the
cloud services are $S_1$ and $S_2$, respectively, and the functional similarity operations are as follows. Semantic (operation and text description) similarity between cloud services.

(1) Operational similarity

$$sim_1 = \frac{W_{op1} \ast W_{op2}}{\| W_{op1} \| \ast \| W_{op2} \|}$$

(2) Text similarity

$$sim_2 = \frac{W_{th1} \ast W_{th2}}{\| W_{th1} \| \ast \| W_{th2} \|}$$

Integrate semantic similarity between services.

$$Fucsim(S_1, S_2) = \frac{1}{2} \ast (\frac{W_{op1} \ast W_{op2}}{\| W_{op1} \| \ast \| W_{op2} \|} + \frac{W_{th1} \ast W_{th2}}{\| W_{th1} \| \ast \| W_{th2} \|})$$

If $Fucsim(S1, S2) \geq \delta$, the two services are similar in function, where $\delta$ is a threshold.

4.2 Selection of Service Quality

In the aspect of service quality optimization, we use the newly developed binary semantics to deal with the service quality. This paper proposes a method of subjective and objective attribute weight integration based on binary semantic information processing [9]. Firstly, binary semantic integration operator is used to calculate the subjective weight of invalid service attributes, and then an objective weight calculation method based on minimum deviation is proposed. According to the similar service matrix given in service cluster, the deviation of attribute judgment of decision-making group is calculated. The larger the deviation is, the larger the quality gap between the service and the actual service is, the smaller the weight value of the attribute, the better the consistency of service quality. On this basis, the subjective and objective weight information of attributes is integrated to get the comprehensive weight of attributes.

Through the above two aspects of function and quality optimization, the candidate set of service replacement is formed. Based on the selection set of service replacement, the invalid service is replaced, which can reduce the search space and improve the replacement efficiency.

5. Service Replacement Algorithm

On the basis of the service substitution candidate set, Word2Vec is used to train the word embedding of each cloud service in the candidate set, and the word vector is generated. By calculating the cosine value of the word vector of the two cloud services, the similarity of the two cloud services is obtained, and the cloud service with high similarity is replaced with the invalid service. For example, there are two vectors $a$ and $b$, where $(x_1, y_1)$ represents the component of vector $a$, $(x_2, y_2)$ represents the component of vector $b$. And $\cos \theta$ is the cosine value of the included angle, which ranges from -1 to 1.

$$\cos \theta = \frac{a \ast b}{\| a \| \ast \| b \|} = \frac{x_1 x_2 + y_1 y_2}{\sqrt{x_1^2 + y_1^2} \ast \sqrt{x_2^2 + y_2^2}}$$

If the cosine value of the included angle is between 0 and 1, then any two vectors have similarity, and the closer the cosine value of the included angle is to 1, the higher the corresponding similarity; if the cosine value of the included angle is between 0 and -1, then any two vectors are different.
6. Simulation Experiment
This paper proposes a service replacement method based on service cluster, which shortens the service search space to a certain extent and improves the replacement efficiency. In order to verify that this method is more effective and service response time is short, we have carried out a series of experiments to compare with the method proposed by previous researchers. This paper mainly takes san's method [10] and Sara's method [11] as reference objects. The main reason is that the two methods do not adopt the form of clustering, which can make the experimental effect more obvious. In this paper, through five experiments to compare, in order to make the experimental data more convincing, each experiment is carried out many times. In this experiment, 10000 services are used. According to the different applications, these services are trained in groups, and 2000 services are added from 2000 to 10000. Finally, the average value of the experiment is taken for comparison. The number of cloud services and service clusters in each round is shown in Table 1.

| round | Number of cloud services | number of service clusters |
|-------|--------------------------|----------------------------|
| 1     | 2000                     | 100                        |
| 2     | 4000                     | 200                        |
| 3     | 6000                     | 300                        |
| 4     | 8000                     | 400                        |
| 5     | 10000                    | 500                        |

Through the above experiments, it can be concluded that the research of service replacement based on service cluster can save the replacement time to a certain extent. Compared with the research method without clustering, with the increasing number of cloud services, the experimental effect is more obvious and the advantages are more prominent, as shown in Figure 2. Therefore, we can conclude that the service replacement method based on service cluster can save time and improve efficiency.

![Figure 2. Comparison of algorithm execution time](image)

7. Conclusion
In order to replace effective services efficiently and reasonably, this paper proposes a service replacement method based on service. This method greatly reduces the search space for alternative services by introducing clusters. In order to get the candidate set of alternative services, the candidate set of services is obtained through the calculation of functional similarity and the selection of service quality. The simulation results show that the service replacement based on the candidate set can greatly improve the replacement efficiency. Especially in the replacement of a large number of cloud services, the advantage of this method is more obvious.

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