Web Service Optimization Selection Model based on QoS Attributes

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Abstract. The optimal choice of Web services based on quality of service (QoS) is a hot issue. Quality of Service (QoS) describes the ability of a service to meet consumer needs. And providing guaranteed QoS is key to the success of Web services in business applications. However, the processing of QoS parameter is too complicated currently. Aiming at the complex QoS parameter processing in Web service selection, a new Web service selection optimization model based on QoS attributes is proposed. The model classifies the QoS attributes, simplifies the processing of QoS parameters, and gives the implementation ideas of related algorithms.

1.Introduction
With the rapid development of Web services, a large number of functionally identical Web services emerged in an open network environment such as the Internet. How to choose the service that best meets the needs of users among many services has become an urgent problem to be solved. The Quality of Service (QoS) of Web services plays an important role in the discovery and selection process of Web services. The existing Web services architecture completes service registration, discovery, binding, etc., but has fewer considerations for QoS. A large number of models have been proposed for QoS research. These studies include the Web service model and architecture proposed in the literature [1~3], and the QoS-driven service selection method proposed in [4~10]. Domestic scholars have also carried out more research on this issue.

Looking at these results, their research is based on two basic ideas: 1) Introduce a new infrastructure to solve the QoS problem of Web services. 2) Extend the functionality of UDDI to perform QoS parameter management. In the Web service selection algorithm, these QoS parameters are matched one by one according to the weight, and finally the service that meets the consumer's needs is returned. The above model and algorithm have an important drawback: the Web service discovery process and the corresponding architecture become complex, and the service selection complexity is high. On the one hand, in the process of performing service discovery and selection algorithm, it is required to understand all QoS attributes and their parameters, which increases the complexity of the algorithm and reduces the success rate of matching. On the other hand, the matching process is lengthy, and the parameters that consumers care about may be a few of all QoS attributes. Based on the existing Web service architecture, this paper proposes a Web service optimization selection model based on QoS attributes to solve the defects in traditional QoS processing.
2. QoS parameter model

The classification of QoS attributes of Web services is shown in the figure [11-15]. Shuping Ran is divided into five categories in the literature [8]: runtime-related QoS, transaction support-related QoS, structure management-related QoS, cost-related QoS, and security-related QoS.

| Web service QoS | QoS parameter classification | Parameter Description |
|-----------------|-----------------------------|-----------------------|
| runtime-related QoS | throughput, response time, delay, etc. | |
| Transaction support-related QoS | usability, accessiblity, etc. | |
| structure management-related QoS | data integrity, transaction integrity | |
| cost-related QoS | cost, price | |
| security-related QoS | consistency, failure rate, repairability, etc. | |

Let the comprehensive QoS parameters of service $S_i$ be $\text{OverallQoS}_i$, which is characterized by the $n$ QoS parameters of the service, namely $\{Q_1, Q_2, \ldots, Q_n\}$.

2.1 Parameter normalization

In different definitions and implementations, different parameters have different expressions and numerical ranges, and some QoS parameters have a negative impact on service evaluation. The larger the value, the lower the service QoS evaluation should be, such as service cost, response time, etc. Some QoS parameters have a positive impact on service evaluation. The larger the value, the higher the QoS evaluation of the service, such as availability, reliability, etc. For comprehensive evaluation, the QoS parameters need to be normalized to make all QoS parameters have the same range. Normalization uses the following linear method.

Let the $j$th QoS parameter of service $S_i$ be the Maximum value is $\max Q_j^i$, the Minimum value is $\min Q_j^i$, the Current value is $\text{cur} Q_j^i$. The normalization is expressed as

$$Q_j^i = \begin{cases} 1 & \text{max} Q_j^i - \text{min} Q_j^i = 0 \\ \frac{\text{max} Q_j^i - \text{cur} Q_j^i}{\text{max} Q_j^i - \text{min} Q_j^i} & \text{max} Q_j^i - \text{min} Q_j^i \neq 0 \end{cases}$$

$$Q_j^i = \begin{cases} 1 & \text{max} Q_j^i - \text{min} Q_j^i = 0 \\ \frac{\text{cur} Q_j^i - \text{min} Q_j^i}{\text{max} Q_j^i - \text{min} Q_j^i} & \text{max} Q_j^i - \text{min} Q_j^i \neq 0 \end{cases}$$

among them $i = 1, 2, 3, \ldots, j = 1, 2, 3, \ldots, n$.

Obviously, the above formula limits the value of $Q_j^i$ to the range of $[0, 1]$, wherein the QoS parameters that have a negative impact on the service evaluation are processed using equation (1), and the QoS parameters that have a positive impact are processed using equation (2).

2.2 Parameter model

Assume that all QoS parameters of service $S_i$ have been normalized, using a weighted and comprehensive evaluation model:
\[ \text{OverallQoS} = \sum_{j=1}^{n} w_j Q_j^i \]
\[ i = 1, 2, 3, ..., j = 1, 2, 3, ..., n. \]  \hspace{1cm} (3)

In equation (3), \( Q_j^i \) is the \( j \)th QoS parameter of the service, \( w_j \) is the weight coefficient corresponding to the parameter, Satisfy \( \sum_{j=1}^{m} w_j = 1 \). \( \text{OverallQoS}_i \) is the evaluation parameter value of \( S_i \). Obviously, the factors that affect the results of the integrated parameters depend on \( w_j \) and \( Q_j^i \). \( w_j \) is set in a system that is based on the importance of the parameters. Therefore, the level of \( \text{OverallQoS}_i \) depends on each QoS parameter of each service, and its value is in the range of \([0, 1]\). The larger the value, the better the overall performance.

3. Architecture

3.1 QoS Architecture

In Web services, the architecture that supports the QoS model consists of four parts: the service consumer, the service provider, the service registry, and the QoS management center. Among them, the QoS Management Center is a new infrastructure introduced in the existing Web service architecture. It is responsible for the acquisition, management and evaluation of QoS-related parameters. Its composition is shown in Figure 1.

![Figure 1. QoS architecture](image)

The service requester provides functional parameters and QoS parameters when searching for a service to implement service selection. The service provider provides its guaranteed QoS for the release and invocation of services and for the need for QoS evaluation.

In the QoS management center, the management and maintenance of various service QoS parameters are implemented to provide support for evaluation and service selection. The evaluation algorithm implements normalization of parameters and calculation of integrated parameters based on QoS parameter data.

3.2 Evaluation and update

The acquisition and evaluation of QoS parameters should be synchronized in time, and each time the QoS management center obtains data once, it can perform an evaluation. In this model, the acquisition and evaluation of QoS parameters adopts an event-driven approach, which is based on the data changes that lead to an evaluation activity. The events that may cause QoS parameter data changes in the QoS parameter-based Web service model are: service provision Registration and logout; publishing and unregistering of web services and the end of a web service use. The use of event-driven avoids the lag of evaluation, making the update timely and accurate.
4. QoS parameter synthesis service selection algorithm

In the service selection algorithm of QoS parameter synthesis, a candidate service set is first generated according to the function of the service required by the service consumer, and then sorted according to the corresponding guaranteed comprehensive parameters to form a candidate service ordered set S. For the service included in S, obtain the corresponding comprehensive parameter value OverallQoS in the QoS management center, and select the required resources. Let the functional parameter proposed by a consumer C be FC and the comprehensive parameter be OverallQoSC. The algorithm is described as follows:

Algorithm: Service Selection Algorithm Based on QoS Synthetic Parameters
Find Services (FC, OverallQoSC, S)

\{ S = \emptyset; Invoke=false; \\
For every Si do \\
If (FC<=Fi) then \\
S=S+Si; \\
if S = \emptyset then break; \\
Sort S by OverallQoS as increase \\
For every Sj \in S do \\
If (OverallQoSj!=null && OverallQoSj>=OverallQoSC) then \\
{Invoking Sj; \\
Invoke=true; break; }
if Invoke=false then \\
Return("no service is available!"); 
\}

The algorithm is selected in the set S for the comprehensive parameters. OverallQoSC \leq OverallQoSj and The value of (OverallQoSj - OverallQoSC) is the smallest, Achieve reasonable choice of services in comprehensive parameters, The waste of service is formed by selecting the service with the highest quality QoS parameter, No longer choose the largest OverallQoS parameter because waste of service. This provides a service with high quality assurance to consumers with higher QoS requirements and achieves load balancing.

5. Model analysis

1) Load balancing. Transfer the evaluation to another infrastructure to complete the load balancing of the system as a whole.

2) Optimization of the service selection process. The service selection process is optimized due to the integrated parameter QoS synthesis parameter algorithm, which reduces the iterative process caused by matching one by one on the QoS parameters.

3) Maximize service utilization. The QoS synthetic parameter algorithm no longer targets the best service for a single QoS, but attempts to maximize the utilization of the entire system service within the scope of meeting the request requirements. That is, when selecting a service, look for a comprehensive parameter in the candidate service to satisfies the foot OverallQoS_C <= OverallQoS_j and min(OverallQoS_j - OverallQoSC) 's service.

6. Conclusion

The article comprehensively processes the various QoS parameters of the service to form a comprehensive parameter, and realizes the selection and calling of the service based on the parameter. On the one hand, it reduces the complexity of service selection, improves service matching efficiency, and achieves call optimization. On the other hand, the algorithm selects the optimal service, that is, the service that satisfies the functional requirements and QoS requirements of the service consumer and is closest to the QoS requirement, and realizes the overall optimization of the service.
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