A Sort of Web Service Selection Strategy Based on the Fusion of QoS and Service Reliability

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Abstract

Aimed at the Web function being too similar to quickly filter out Web services, the paper proposed a sort of selection strategy in Web service based on the fusion of QoS and reliability. The paper made the analysis on the limitations of the current selection mechanism and evaluated the Web service selection from two aspects in subjectivity and objectivity and constructed the model of Web service selection based on the model of QoS monitoring, target consumption group, service quality estimation and feedback evaluation. It took three cases as example to make the simulation and validated that the proposed strategy not only could adapt dynamic varying environment, but also could ensure the actual service quality and overcame the individual difference of evaluation. The research results demonstrate that the proposed strategy of service selection can filter speedily out the Web service needed by requester from the set of Web service in abundance.

Keywords: Web Function, Web Service, Fusion, Quality of Service, Service Reliability, Selection Strategy.

1. Introduction

The selection mechanism of Web service has gone through two stages, namely the QoS based selection and user evaluation feedback based selection. The former is a sort of service selection method based on objective evaluation. Its selective model is shown in Fig.1. The module of ServiceMatchMake in Fig.1 is used for match evaluation in QoS of Web services that meet the functional requirements, but the precondition is that the data in QoS must be truly credible. Practically, there are a large number of false services in the network. The model ignores the dynamic changes in QoS, therefore, the selected service based on QoS may not be the best service. The later is based on user evaluation feedback. Its service selection model is shown in Fig.2. Its accuracy depends on the actual effect of service evaluation from the service consumer. It is a sort of service evaluation method based on subjective evaluation. Therefore, it is difficult to obtain the high quality Web service.
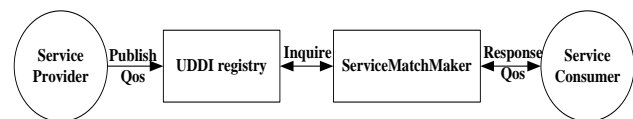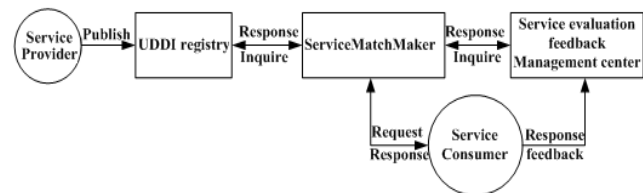

Fig. 1 Web service selection model based on QoS.

Fig. 2 Web service selection model based on feefback.

In the evaluation methods mentioned above, the user feedback owns one-sidedness, and the subjective evaluation has its limitations. In addition, the selective method suffers the influence of context dependency in user feedback. Aiming at the puzzles mentioned above, lots of scholars have researched deeply into these puzzles. Zhang Wen-bo and Shi Wei-feng researched the dynamic Web services composition based ion BPEL and QoS[1]. Gao Ya-chun and Zhang Wei-qun explored the Web Service Description and Selection Mechanism Based on QoS Ontology[2]. Chen Li-jin and Zhou Ya researched Dynamic Web Service Selection based Multi-QoS constraints[3]. Yang Mo and Wang Li-na researched Web service reliability enhancement method based on trust fault tolerant[4]. The authors think what cause puzzles of selection model based on QoS or based on user evaluation feedback is that the model built can not reflect completely the essence of objects. Therefore, the paper made further study on selection strategy of Web service based on QoS and confidence fusion in order to get a better selection model.

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2. Improvement on Selection Strategy

Aimed at the puzzles of one-sidedness and limitation mentioned above, in order to avoid false QoS made by service provider in the attribute value of QoS for objective evaluation, the monitoring mechanism of QoS was introduced. Moreover, the model of object consumer group was introduced to overcome the influence of context dependency in user feedback. And the model can distinguish effective and invalid evaluation so as to put an end to the influence of invalid evaluation for Web service.

2.1 QoS Monitoring Model

The monitoring model was shown in Fig.3. It can make the monitoring and update of QoS attribute value periodically to ensure the confidence and real time effectiveness of QoS attribute value. Suppose the Web service to be as S_i , QoS attribute value as $Q_i = \{q_{i,1}, q_{i,2}, \ldots, q_{i,n}\}$, then Q_i can be updated as shown in Eq.(1).

$$Q_i = w \times Q'_{i,0} + (1-w) \times f(Q'_{i,1}, Q'_{i,2}, \ldots, Q'_{i,j}) \quad (1)$$

Where, $Q'_i = \{Q'_{i,1}, Q'_{i,2}, \ldots, Q'_{i,j}\}$ is the QoS data collected by monitor, $Q'_{i,0}$ is the initial QoS data provided by service provider. w is the weight of initial QoS and it expresses by exponential function $1/2^n$, and n is the data number collected by monitor. Therefore the weight value of initial QoS can be adjusted dynamically with increase of collected data amount, namely the specific weight of $Q'_{i,0}$ gets more and more small in the computation. f is a statistical function as shown in Eq.(2).

$$f(Q'_{i,1}, Q'_{i,2}, \ldots, Q'_{i,j}) = \frac{1}{j} \sum_{m=1}^{j} \lambda^{date(t-t_m)} Q'_{i,m} \quad (2)$$
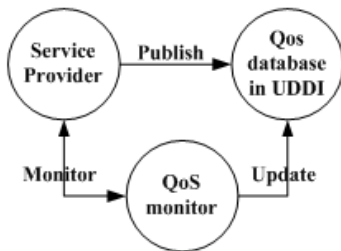

Fig. 3 QoS monitoring model.

2.2 Target Consumption Group Model

The model of target consumption group was shown in Fig.4. For a certain service, the consumers can be divided into m individual group. With regard to Web service S_i ,

it puts up two announcement parameters, namely the announcement vector QoS of service quality and target service group of the service. For any target group of them, it can be identified by a unique service quality vector, namely $TCGroup_{i,k} = TCGQoS_{i,k}, 0 < k \le m$. For such a target group, it can also be expressed as $TCGroups_i = [TCGQoS_{i,1}, TCGQoS_{i,2}, \cdots, TCGQoS_{i,m}]$.
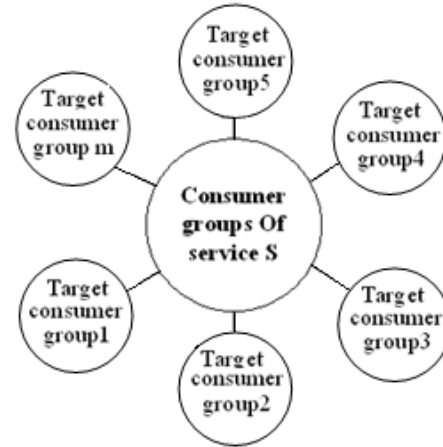

Fig. 4 Target consumer group model.

The flowchart of classification for target consumer was shown in Fig.5. The service provider can locate several consumption groups for service S_i , it can be expressed as $TCGroups_i = [TCGroup_{i,1}, TCGroup_{i,2}, \cdots, TCGroup_{i,m}]$. For service consumer C , the requirement quality is expressed as Q_c , and after computing the similarity between Q_c and $TCGroup_{i,1}$, $TCGroup_{i,2}$, ..., $TCGroup_{i,m}$, it sorts according to rule from big to small, elects target consumption group of biggest similarity, and makes it join in the target consumption group. The measure of similarity difference is adopted by cosine similarity value, because it mainly focuses on the difference in direction of two vectors, and not distance or length. The similarity value is directly mapped into the interval [-1, 1], and the dependency value lies on the between from -1 to 1. In which, "1" shows completely positive correlation, and "-1" represents completely negative correlation.
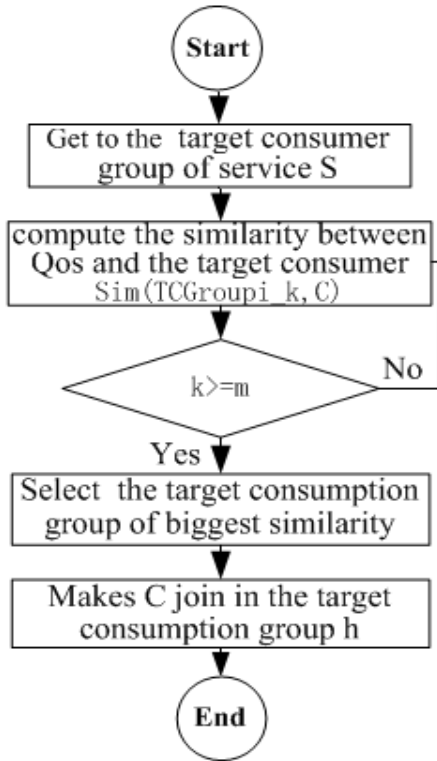
Fig. 5 Flowchart of position target consumer groups for service consume.

Assume the requirement QoS of service consumer C to be as $Q_c = \{q_{c,1}, q_{c,2}, \ldots, q_{c,n}\}$, and the QoS feature of target consumption group $TCGroup_{i,k}$ of service provider is $TCGQoS_{i,h} = \{tq_{i,h,1}, tq_{i,h,2}, \ldots, tq_{i,h,n}\}$, then the similarity between the both can be expressed by Eq.(3). If the value is smaller then it shows that the similarity between the both is bigger.

$$Sim(Q_e, TCGQoS_{i,h}) = \frac{\sum_{j=1}^{n}(q_{c,j} tq_{i,h,j})}{(\sum_{j=1}^{n} q_{c,j}^2 \sum_{j=1}^{n} tq_{i,h,j}^2)^{\frac{1}{2}}} \quad (3)$$

2.3 Service Evaluation Model

The model of service evaluation makes evaluation service from two aspects, namely subjective and objective evaluation. The service selection model based on QoS monitoring and evaluation classification can make QoS own the real effectiveness through introducing time factor to update the QoS dynamically. The confidence of consumer for Web service comes from direct confidence and indirect recommendation confidence, and after respectively computing it can obtain the totality confidence of candidate Web service. It is shown as Eq.(4).

$$T = w_t \times DirectTrust + (1 - w_t) \times IndirectTrust \quad (4)$$

In which, w_t represents the confidence weight.

2.4 Evaluation Feedback Model

The user evaluation feedback management model can be shown in Fig.6. In which, each service has m target consumption groups, and anyone service consumer must be assigned into a target consumer group. The service evaluation of one and the same target consumption group also must be put into the same storage pool. If the feedback information does not belong to the malicious evaluation then it must be encouraged and rewarded, else it must be punished for evaluation of service consumer. The mechanism of evaluation of rewards and punishments can make corresponding reward and punishment according to average evaluation similarity of belonged target consumer group. If it is high for the average evaluation similarity of the service consumer group, then it illustrates that the evaluation confidence is higher, and when it is greater than a certain getting value then it can be considered that the evaluation made by service consumer is impartial, it should be encouraged and rewarded. In opposite it should be punished. The mechanism of rewards and punishments can reduce the malicious evaluation.
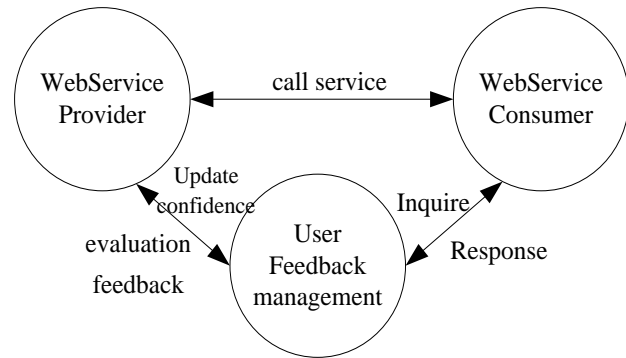

Fig. 6 User feedback management model.

3. Service Selection Strategy Based on Fusion

By means of service confidence evaluation and the third side monitor of service quality, based on the service selection mechanism of service classification and confidence, suitable user service can be selected according to the objective service quality value of comprehensive evaluation and user subjective evaluation value.

3.1 Service Selection Algorithm Flow

The flow of service selection algorithm was shown in Fig.7. The steps of the algorithm: 1)To make semantics

matching and short-cut process constraint processing for announcement vector set of candidate service; 2)To make evaluation for announcement vector of candidate service. In which, the vector formed by correlation attribute value of all QoS of anyone service is called as service announcement vector; 3)To find out the target consumption group in the confidence evaluation, to compute direct confidence value, to find out all evaluation of the target consumption group, and to compute indirect confidence value of the target consumption group for the service consumer; 4)To dispose the above evaluation results synthetically, and return the final evaluation result.
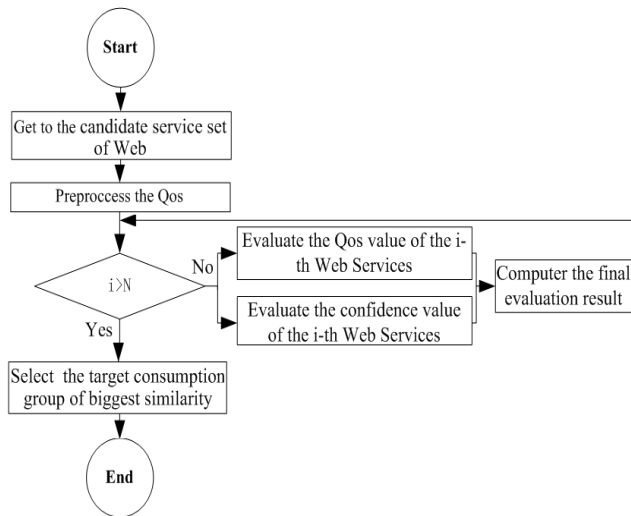

Fig. 7 User feedback management model.

3.2 QoS Constraint Processing

Semantics matching of QoS. It first makes semantics matching for service request QoS and service announcement QoS[5-7], and it can obtain the service announcement vector set Q_v of semantics matching satisfied by the service request vector.

Short-cut process constraint of QoS. In order to unify the computing and comparative analysis, by means of unit transform mode of UnitConversion record in ontology Database, it makes single standard processing for measure mode of QoS service announcement vector. The classification of short-cut process constraint of QoS constraint consists of numerical value type and Boole type and grade type, and the short-cut process constraint makes short-cut process constraint processing for service announcement set of satisfied QoS semantics matching.

3.3 Constraint Processing of QoS

After QoS constraint processing, it can obtain the Web service candidate set $S = \{S_1, S_2, \ldots, S_m\}$, and each service has n pieces of QoS attribute, therefore it can constructs a $m \times n$ matrix Q as shown in Eq.(5). In the matrix Q , each row represents a Web service, and each column represents one and the same QoS attribute.

$$Q = \begin{bmatrix} Q_1 \\ Q_2 \\ \vdots \\ Q_m \end{bmatrix} = \begin{bmatrix} q_{1,1} & q_{1,2} & \cdots & q_{1,n} \\ q_{2,1} & q_{2,2} & \cdots & q_{2,n} \\ \vdots & \vdots & & \vdots \\ q_{m,1} & q_{m,2} & \cdots & q_{m,n} \end{bmatrix} \qquad (5)$$

In the matrix Q , the large the numerical value is, the beneficial for service request. According to the QoS attribute after quantization it can compute the QoS evaluation value of Web service, and it is shown as in Eq.(6).

$$QoS(S_i) = \frac{1}{n} \sum_{p=1}^{n} q_{i,p} \qquad (6)$$

3.4 Confidence Evaluation

It has been researched on confidence[8-10], but they ignored all the correlation of context, and it results in different for the same service confidence in different service consumer. Aimed at the shortage mentioned above, the paper firstly seeks that the service consumer belongs to which target consumption group of the service, then after seeking attribute target consumption group it can find direct confidence value through computing. Finally according to Eq.(7), it can find the indirect confidence value.

$$Indirect-Trust(C,S_i,t)$$
$$= (\sum_{r=1}^{z} RP_{c,r} \times valfr_{i,r} \times \lambda^{date(t-t_r)}) / z \qquad (7)$$

In which, $RP_{c,r}$ gives the confidence of service consumer of $fr_{i,r}$, $valfr_{i,r}$ is the evaluation score of consumer for service S_i .

3.5 Web Service Selection

After completing the evaluation $S = \{S_1, S_2, \cdots, S_n\}$ of all services, it can obtain an evaluation matrix $ER = \{ER_1, ER_2, ..., ER_n\}$ of comprehensive considering QoS as well as confidence. Sorting the element in *ER* from big to small, it can obtain the biggest value ER_i in *ER* , and the service S_i of the biggest value ER_i must be the only section. The above flow joined the evaluation computing

of user evaluation value of requirement similarity, and the evaluation value joined more actual subjective judgment information, therefore it enhanced the service precision ratio, and it can satisfy the QoS selection requirement of user Web service in a certain grade.

4. Implementation of Service Selection Strategy

4.1 Service selection frame

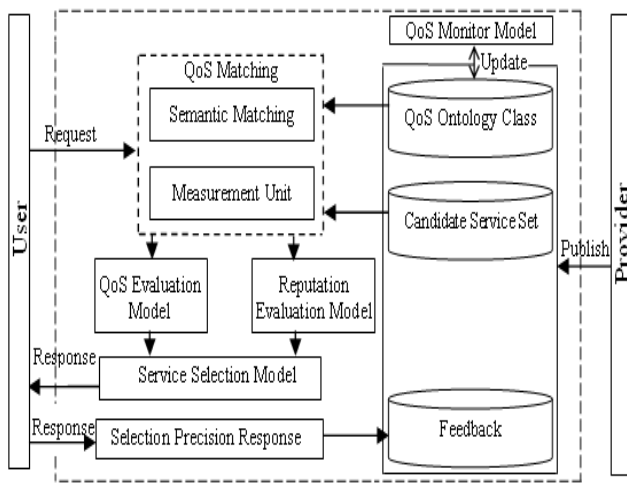The total frame of service selection mechanism implementation was shown as in Fig.8.

Fig. 8 Service selection frame.

1)The service monitor module QoSMM is in charge that it monitors the QoS vector of service announcement, stores the history data of monitoring, and updates the parameter value of QoS announcement vector periodically.

2) The pretreatment module QMM makes pretreatment for service request QoS vector and service announcement QoS vector, including QoS parameter semantics matching and constraint treatment of QoS parameter short cut process, and it makes all QoS parameter standardization.

3) The evaluation module QEM makes average value computing for result set QoS, and finds out the QoS evaluation value. The input of module QEM is the result set of pretreatment module QMM.

4) For confidence evaluation module TDEM, the input is the module QMM. It produces candidate service set after through QoS matching. It finds out the target consumption group stated by service request in the candidate service according to the service request QoS vector, and then it makes evaluation estimate according to the evaluation value provided by target consumption group.

5) The service selection module SSM makes the sum of evaluation value produced by QEM and TDEM according to the weight value, and then makes sorting for candidate selection, and finally it selects the service in front of M service of candidate set, and return to the service consumer.

6) Module SPRM of user satisfaction investigation is in charge of collecting user satisfaction degree of process execution result in service selection.

4.2 Response Mechanism of Service Request

The flow of response mechanism was shown as in Fig.9. After receiving the QoS service request, through four processing flow it can provides the response result. 1) It can create a new QoS matrix after the candidate service set through the QoSMM QoS pretreatment. 2) QEM module completes the evaluation for QoS. 3)TDEM module finds out the target consumption group according to the requirement QoS of service consumer, and it computes the user evaluation value and completes the confidence evaluation. 4) SSM module is in charge of service selection, and makes its result provide to service consumer.
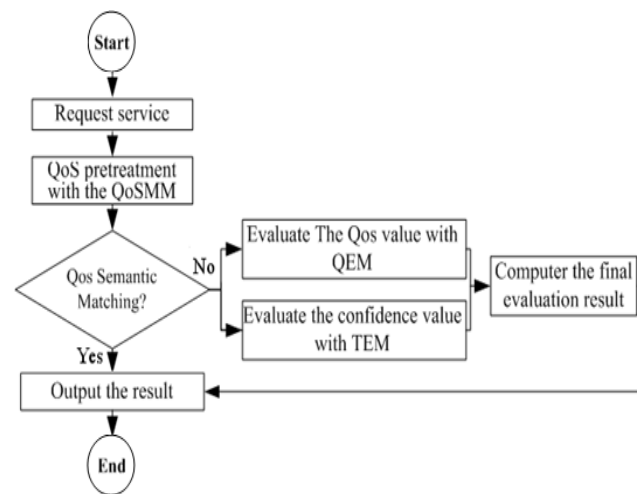

Fig. 9 Response flow of service request.

In the confidence model of the proposed mechanism, it owns the comparability because of the criterion being based on the evaluation of the same target consumption group, and therefore it can finds out the most suitable service of requirement itself for user.

5. Experiment Simulation

For convenience of comparison and description, here the algorithm of Web service selection based on QoS is called as SMQ, and the mechanism of service selection based on

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QoS and user feedback is called as WSMQF. Compared WSMQF with SMQ algorithm, it increased the steps of feedback evaluation, and therefore it increased the time cost. Compared WSMQF with SMF algorithm, it increased two steps of evaluating QoS and seeking target consumption group, therefore its time cost is also increased a little. But after locating the belonged target consumption group, because the number of user evaluation is reduced compared with the original, so the time cost is also reduced. The following is the test results of simulation contrast for the time cost of three sorts of algorithm under different conditions.

1) For the service consumer C , under the condition of invalid evaluation being fixed, with the increasing of valid evaluation number, the simulation result of time cost is shown as in Fig.10 under different mechanism. With the increasing of valid evaluation, the time cost of WSMQF is also increased. Related to SMF, under the condition of the same number of invalid and valid evaluation, the time cost of WSMQF is less than SMF. SMQ does not deal with user feedback and only deals with static state QoS evaluation, and therefore its time cost is less, and basically it is not changed steadily.
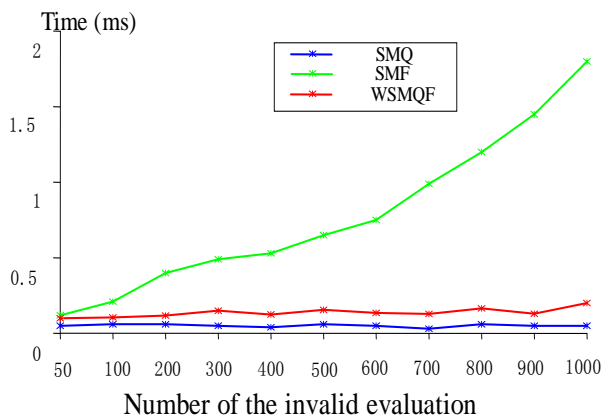

Fig. 10 Time spending under different invalid evaluation.

2)For service consumer C , under the condition of valid evaluation number being fixed, with the increasing of invalid evaluation, the simulation result of time cost of WSMQF is shown as in Fig.11. With the increasing of invalid evaluation, the time cost of WSMQF keeps a stable value basically, and the time cost of SMF is increased with invalid evaluation increasing. And the time cost of SMQ is the same as 1), and it is in a stable status.
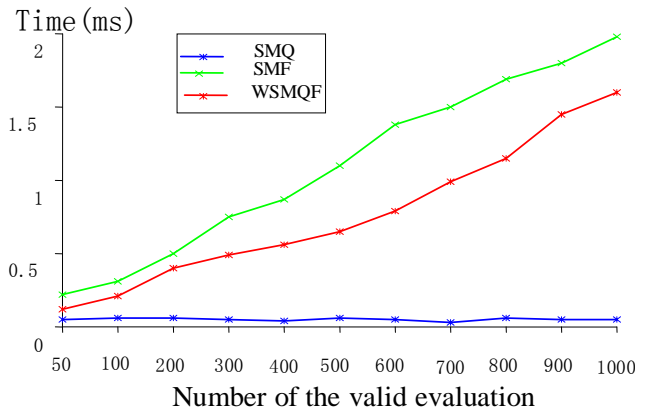

Fig. 11 Time spending under different valid evaluation.

3)Simulation experiment on the precision ratio
The precision ratio shows that after according to the requirement QoS of service consumer selecting the service for consumer, the selected service number of times takes a percentage of ideal service number of times of service request in the service selection system. Aimed at the precision ratio, the statistical result of simulation for proposed algorithm is shown as in Fig.12.
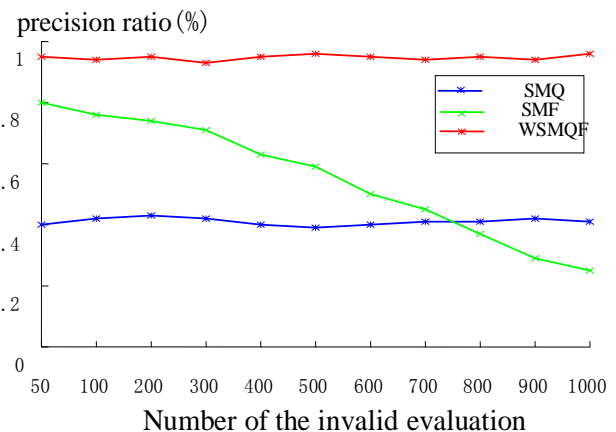

Fig. 12 Selection precision ratio under different invalid evaluation.

Compared with the simulation result it can be seen that the precision ratio of SMQ is lower, and the precision ratio of SMF is reduced with the increasing of invalid evaluation, but the precision ratio of WSMQF is also to keep a higher level, and it can not be reduced with the increasing of invalid evaluation. From the simulation experiment, it can also be seen that the time cost of SMQ is less, but the precision ratio is less. The time cost of SMQ SMF is higher than SMQ does, but related to SMQ it is still high.

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Compared with SMF, the time cost of WSMQF is less, but compared with SMQ, the time cost is big a little, and the precision ratio is the highest and the most stable in the three sorts of selection mechanism. From the above mentioned, we can see that under the condition of acceptable time cost, the time cost of WSMQF has obvious improvement in precision ratio.

6. Conclusions

The paper explored in detail the selection strategy of Web service based on the fusion of subjective and objective evaluation for QoS aiming at the puzzle of Web service selection for functional similarity. By means of simulation experiment, the rationality and effectiveness of the service selection strategy had been validated preliminarily. In view of the complexity of service selection mechanism, it is still necessary to make further research to some puzzles, such as how to make reasonable partition for target consumption group according to the actual requirement, how to determine initial confidence value of service consumer so as to restrain the malicious evaluation of service consumer.

Acknowledgments

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