A Trust and Reputation Management Framework for Web Services

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\textbf{Abstract.} A trust and reputation evaluation method for web services is proposed based on a similarity mining technique. A reputation evaluation algorithm for the new added web service is proposed based on the similarity theory. Similarities and trusts are used as weights for computing reputations from different recommenders. Updating algorithms for trusts and reputations are proposed.

\textbf{Keywords:} trust, reputation, web service selection, similarity

1 Introduction

Trust and reputation are essential criterions for best web service selection. Reputation is a subjective assessment for a web service based on the user’s own experience and recommendations from neighbors. A weight for a recommended reputation is depended on how much the user trust the recommender.

This paper proposes a reputation evaluation method for web services based on similarity mining technique. A reputation evaluation algorithm for the new added web service is proposed. The similarity evaluation method is based on the approach in [1]. Updating algorithms for trusts and reputations are proposed.

2 Trust and Reputation Management Framework

2.1 Similarity Mining

Let $S = \{s_1, s_2, \cdots, s_m\}$ is the set of services with the same function. $U = \{u_1, u_2, \cdots, u_n\}$ is the set of service consumers. $P = \{p_1, p_2, \cdots, p_n\}$ is the set of QoS properties of a service. $Q_{ij} = \{q_{ij}\}$ represents the property values of

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p_j for s_i. Blanks in the table represent no reputation information of the target services. \( R_{i,j} = \{ r_{ij} \} \), \( r_{ij} \in \mathbb{R} \), represents the reputation for \( s_j \) in \( u_i \), where \( 0 \leq r_{ij} \leq 1 \). \( r_{ij} \) is proposed by the service provider of \( s_j \). \( \mathbb{R} \) represents the set of real numbers.

Similarity between two nodes based on Euclidean distance [2] is computed according to Eq. 1 which is proposed in [1]. X and Y are vectors. \( X_i \) (or \( Y_i \)) represents the value of the \( i \)-th dimension in the vector.

\[
w = \frac{1}{\left( \sum_{i=1}^{n} (X_i - Y_i)^2 / n \right)}
\]  

(1)

2.2 Direct Experience Based Reputation

Let \( r_{i,j}^{(n)} \) be the reputation for service \( j \) given by the consumer \( i \) after the \( n \)-th calling. The comprehensive reputation of \( n \)-times calling is represented as \( R_{i,j}^{(n)} \). The comprehensive reputation can be calculated by Eq. 2. \( \alpha (0 \leq \alpha \leq 1) \) is the history factor. Eq. 2 is also used as reputation updating formula for service \( j \) from the consumer \( i \).

\[
R_{i,j}^{(n)} = \begin{cases} 
\alpha R_{i,j}^{(n-1)} + (1 - \alpha) r_{i,j}^{(n)} & n > 1, \\
n = 1 
\end{cases}
\]

(2)

2.3 Recommendation Based Reputation

The reputation of the service \( j \) based on recommendation for the consumer \( i \) can be calculated by Eq. 3. \( C_{i,j} \) is the comprehensive recommended reputation of the service \( j \) for the consumer \( i \). \( w_{i,k}^u \) is the similarity between consumers \( i \) and \( k \). \( t_{i,k} \) is trust evaluation of the consumer \( k \) given by the consumer \( i \). \( R_{k,j} \) is the direct experience reputation about the service \( j \) given by consumer \( k \). \( n \) is the number of recommenders.

\[
C_{i,j} = \frac{\sum_{k=1..n,k\neq i} (w_{i,k}^u \times t_{i,k} \times R_{k,j})}{\sum_{k=1..n,k\neq i} (w_{i,k}^u \times t_{i,k})}
\]

(3)

2.4 Reputation of a New Service

The reputation evaluation for the new service \( j \) is based on the reputations of similar services, given by the same consumer. Services similarity is also computed by Eq. 1. The reputation of a new service for the consumer \( i \) can be calculated by Eq. 4.

\[
R_{i,j} = \frac{\sum_{k=1..n,k\neq j} (w_{j,k}^r \times R_{i,k})}{\sum_{k=1..n,k\neq j} w_{j,k}^r}
\]

(4)
n is the number of services which are called by the consumer i in history and hold the same function as the service j. $w_{j,k}^r$ is the similarity between the services j and k. $R_{i,k}$ is the comprehensive reputation of the service k given by the consumer i in history.

2.5 Integrated Reputation

Reputation for a web service is proposed in Eq. 5. $\beta$ ($0 \leq \beta \leq 1$) is the weighting factor for direct experience based reputation. $R_{i,j}$ is the direct experience based reputation for service j given by the consumer i in history. $C_{i,j}$ is the comprehensive reputation of service j given by the neighbors of the consumer i.

$$I_{i,j} = \beta R_{i,j} + (1 - \beta)C_{i,j}$$  \hspace{1cm} (5)

2.6 Trust and Reputation Updating

Trust updating method is proposed in Eq. 6. $T_{i,j}^{(n)}$ represents the comprehensive trust value of the recommender j from the consumer i after n-times calling. $R_{j,k}$ is the reputation of the service k recommended by the consumer j. $r_{ik}$ is the reputation of the service k given by the consumer i after direct calling. $T_{i,j}^{(0)}$ is the initial trust value between consumers. $\delta$ ($0 \leq \delta \leq 1$) is the boundary value for telling whether a recommender is honest or not.

$$R_{i,j}^{(n)} = \begin{cases} 
0.5 & n = 0 \\
T_{i,j}^{(n-1)} - |R_{j,k} - r_{ik}| \times T_{i,j}^{(n-1)} & n > 0 \land |R_{j,k} - r_{ik}| \geq \delta \\
\frac{T_{i,j}^{(n-1)} + |R_{j,k} - r_{ik}|}{8} \times (1 - T_{i,j}^{(n-1)}) & n > 0 \land |R_{j,k} - r_{ik}| < \delta
\end{cases}$$  \hspace{1cm} (6)

3 Conclusion

This paper proposes a trust and reputation management framework for web service selection. Similarity mining technique is used for identifying similarity among users or web services. A reputation evaluation algorithm is proposed for the new added web service based on the similarity theory. Updating algorithms for trusts and reputations are proposed.

References