Subjective Trust Evaluation Model Based on Preferences

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Abstract: In the open network environment, in the face of vast amounts of resources and services, due to the fraud and the existence of unreliable service, the user increased choice, at the same time how to identify and select efficient and secure resources or services. So the trust evaluation has become one of the focuses of current research. Because the trust relationship between entities is highly subjective, uncertainty, ambiguity, drawing on the trust model of human sociology, according to preference entities interested in, considering the various attributes and characteristics, adopts the fuzzy comprehensive evaluation method to trust the entity evaluation. In order to increase the recommended credibility and reliability of recommended entities, the introduction of services similarity algorithm in the Web semantic network, the weighted harmonic and recommendation trust value, in order to improve the reliability of recommended entities, and finally considering the direct trust and recommendation trust of entities, accordingly conclude both meet the current needs of the requesting entity safe and reliable service entities. Finally, simulation experiments performed to verify the validity of model credibility assessment.

Keywords: trust evaluation model, subjective trust, fuzzy comprehensive evaluation, similarity.

0 Introductions

With the computer technology and communication technology continues to evolve, the network environment has been transformed from relatively static, specific organizations and user groups for the closed network early, into publicly accessible, a large number of dynamic user-oriented open network. In the face of vast amounts of resources and services, due to the fraud and the existence of unreliable service, the user increased choice, at the same time how to identify and select efficient and secure resources or services. The current solution is an effective trust evaluation system, and become one of the focuses of current research [1,2].

Trust evaluation system to collect, analyze substantive historical information to predict their behavior in future transactions that may act, thus to select a higher trust entity to transact for user, to reduce the risk of transaction failure, and to avoid losses. Thus, the nature of the trust evaluation system is to assess the behavior of the entity, according to certain algorithms, to get the trust value of the behavior of an entity, for the parties to the transaction reference.

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1 Related Work

In the online world, the establishment of the relationship between entities is based on the judgment of mutual trust. In 1996, Blaze et al address Web services security, first coined the "Trust Management" term [3]. If using the classical precise reasoning method, can not fully reflect the reality of things, because, trust or not is evaluated by the people, is a subjective judgments, and highly subjective, uncertainty, ambiguity [4,5].

Tang Wen et al [6,7] introduce linguistic variables and fuzzy logic to trust management study, adopt a fuzzy measure of trust mechanisms, provide a valuable new ideas to the trust management research. Wang Shouxin et al [8] propose a subjective trust evaluation methods based on cloud model, which evaluates the credibility of entity by the expectation of subjective trust cloud and hyper entropy, then design a trust change cloud model to describe the trust change of entity, and thus provide the basis for the trust decision. Manchala [9] proposed a trust model based on fuzzy logic, proven by introducing the concept of fuzzy authentication to describe the fuzziness of the trust relationship, which depicts the complex and variable relationship between the entities in the model, and solve the problem of fuzzy modeling of trust. The disadvantage is the lack of a direct measure of trust; it would be an exploit of no great difficulty to threatening event and increase the possibility of the system to be attacked. Chen Jiangang et al[10] propose the trust mechanism to access grid resources based on fuzzy set.

Consider the trust relationship between entities is highly subjective, uncertainty, ambiguity in the distributed network environment, according to entities preference, considering the various attributes and characteristics, adopt the fuzzy comprehensive evaluation method to evaluate the trust of entity, introduce services similarity algorithm in the Web semantic network, the weighted harmonic and recommendation trust value, in order to improve the reliability of recommended entities, and consider the direct trust and recommendation trust of entities, accordingly conclude both meet the current needs of the requesting entity safe and reliable service entities.

2 Trust Management Model

2.1 Definition

Definition A. Let X be non-empty domain, x is the element of X, for any x ∈ X, given the following mapping: $X \to [0,1]$, $x \mapsto \mu_A(x) \in [0,1]$, the following set composed by the ordered pair $A = \{x | (\mu_A(x))\}$, is called fuzzy subset on the X, $\mu_A(x)$, is called membership function of x on A(Also can be expressed as A (x)) $\mu_A(x)$, is called membership degree of x on A, x in terms of a specific.

Definition B. Direct Trust: means the trust relationship that established under the direct interaction occurred between of two entities of the system in the past.

Definition C. neighbor entity: entity that has had directly historical transactions with the request entity, is called neighbor entity.

Definition D. service attribute set: the vector composed by the element which can affect the result of inter-entity transaction, is called service attribute set, indicated by $ATTR = \{attr_1, attr_2, ..., attr_n\}$,and $attr_i$ is the No.*i* attribute of the service. To facilitate the calculation, the method using normalized values of all properties into a dimensionless quantity and is in [0, 1].

Definition E. trust level evaluation sets: the set composed by various evaluation results concluded by subjective entity according to the trust level of the objective entity, indicated by $V = \{v_1, v_2, .., v_m\}$.

Definition F. Preference: the subjective desire of service requester entity to the attribute of the service.

Definition G. weight set of service attribute: Different attributes corresponding to different weight coefficients. The set composed by different weight coefficients, indicated by $W = \{\omega_1, \omega_2, ..., \omega_n\}$, and $0 \le \omega_i \le 1$, $\sum_{i=1}^{n} \omega_i = 1$.

2.2 Satisfactions

After each transaction, integrating the service properties, using the Comprehensive Evaluation Method to calculate the value of trust evaluation when the service provider entity $x_j (x_j \in X)$ provided the transaction service to the service requester entity $x_i (x_i \in X)$ indicated by S_k , and *k* is the No. *k-time* transaction. As the following:

(1) Determine the evaluation set, indicated by $V = \{v_1, v_2, .., v_m\}$, any property of service that can be used several fuzzy subsets. The definition as follows:

$v_1 (0 \le R < T_1)$: "no confidence" subset; $v_2 (T_1 \le R < T_2)$ "critical trust " subset; $v_3 (T_2 \le R < T_3)$ "trust" subset; $v_4 (T_3 \le R \le 1)$ "full confidence " subset;

(2) To evaluate single factor of each service attribute, then get the membership vector $r_i = (r_{i1}, r_{i2}, ..., r_{im})$.

(3) To calculate the integrated membership, $B = W \circ R$, of which $\circ$ is the fuzzy composition operator, then get satisfaction vector;

2.3 Value of Direct Trust

If there were n times transactions between entity x_i and entity x_j, when the No.k transaction is completed, taking into account transaction time t_k of the No. k transaction, the transaction amount m_k and the total number of transactions n between entity x_i and entity x_j, the direct trust degree is calculated as:

$$T_d(x_i, x_j) = \begin{cases} 0.5 & n = 0 \\ \alpha \times \dfrac{\sum_{k=1}^{n} f(t_k) \times q(m_k) \times S_k}{n} & n > 0 \end{cases} \quad (1)$$

There into, $\alpha = \sqrt{n/(n+1)}$ is the function about transaction time. $f(t_k) = e^{-\lceil (t_0 - t_k)/T \rceil}$ is attenuation coefficient of trust about time, t_0 is the time of this transaction. The function $q(m_k) = e^{-1/m_k} \quad (m_k > 0)$ is used to adjust the impact of the transaction amount to the evaluation value. This makes it difficult to obtain high confidence with small transactions, to avoid malicious entities to obtain the trust by small transactions then fraud in the large transaction.

2.4 Similarity of Recommendation

To ensure that the recommendation content be credible, we introduce similarity in the Web semantic network, which was assessed by calculating the similarity between the service provider entity provided and the service the requester entity requested, only services provided to meet user requirements be considered as a reliable service. We adopt the model provided by reference[11] to calculate the similarity, denoted by WS.

To adjust the trust value with similarity weighted, so that the higher the similarity, the higher trust value after adjusted. Calculated as follows:

$$ST(x_i, x_k) = \frac{2 \times WS(x_i, x_k) \times T(x_i, x_k)}{\delta \times T(x_i, x_k) + (1 - \delta) \times WS(x_i, x_k)} \quad (2)$$

δ is adjusted factor, $WS(x_i, x_k)$ is the similarity between the entity i and entity j, $T(x_i, x_k)$ is the level of the trust, $ST(x_i, x_k)$ is the final trust value which is adjusted with similarity weighted.

2.5 Trust Level

The trust value of entity x_j, which is calculated through collecting and integrating the recommendation of the neighbor entities by entity x_i, is called recommendation trust, denoted by $T_r(x_i, x_j)$. In calculating the recommendation values, this paper considered the similarity of recommendation, trust value of the recommender entity, the transaction amount of the recommender entity, the number of transactions.

When computing the recommendation value in the domain, according the direct transaction along with the entity x_i, searching the set of recommendation entity L($x_1, x_2, \cdots, x_{Num}$). The value of recommendation in domain, $T_r(x_i, x_j)$, is calculated as:

$$T_r(x_i, x_j) = \sum_{k=1}^{Num} \frac{ST(x_i, x_k)}{\sum_{k=1}^{Num} ST(x_i, x_k)} T_d(x_k, x_j) \tag{3}$$

There into, *Num* is the number of the entity in the set of recommendation entity L.

Integrated direct trust and recommendation trust, come to the entity x_j's general trust of the entity x_i .

$$T(x_i, x_j) = \beta T_d(x_i, x_j) + (1-\beta) T_r(x_i, x_j) \tag{4}$$

The confidence factor β is the direct trust and recommendation trust comprehensive weight, to enhance system reliability. Confidence factor adjustment formula is as follows:

$$\beta = 1 - \rho^k, \rho \in (0, 1) \tag{5}$$

3 Simulations

In order to verify the validity and accuracy of FTSTEM model, we design the simulation experiment of the model based on the PeerSim[13] simulation platform provided by the project team BISON[12]. According to the characteristics of the network entity, the entity node is divided into four types: absolute trust, trust, critical trust and distrust that the partners after a long-term exchange.

3.1 The Variance of Trust Value in Four Types of Entity with the Increase in the Number of Transactions

Suppose: $T_1 = 0.3$, $T_2 = 0.6$, $T_3 = 0.9$. Figure 1 shows the variance of the average value of trust with the increase in the number of transactions.

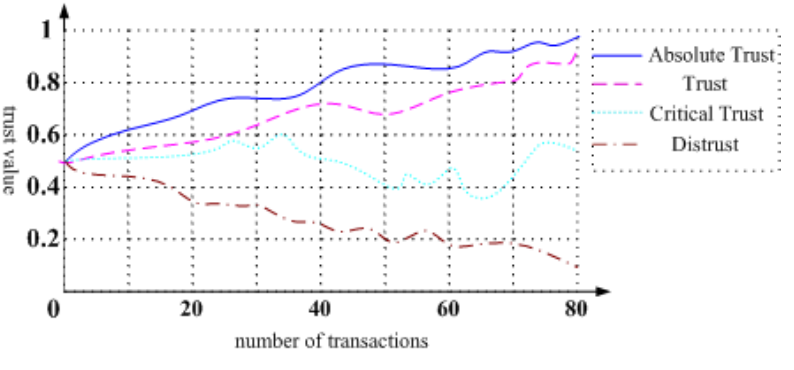

Fig. 1. The variance curve of trust value in four types of entity with the increase in the number of transactions

With the increase in the number of transactions; the new reputation value of each node is updated. The global reputation value of the absolute trust node and the trust node will increase as the number of transactions increase, the trend of the trust value will be increased gradually, and the trust value of the critical trust node showed wavy, the value of the distrust node trust is a decreasing trend. Figure 1 shows that, FTSTEM model reflects well with the trust value of node entities while change the number of transactions, meet the expectations of the analysis.

3.2 Success Rate of Transactions in Model FTSTEM VS. EigenRep

Model simulation transaction is successful or not, is judged according to the user's satisfaction feedback. When the satisfaction is greater than 0.6, we will consider the transaction is successful, otherwise fail. Transaction success rate is expressed as the number of successful transactions in all proportion.

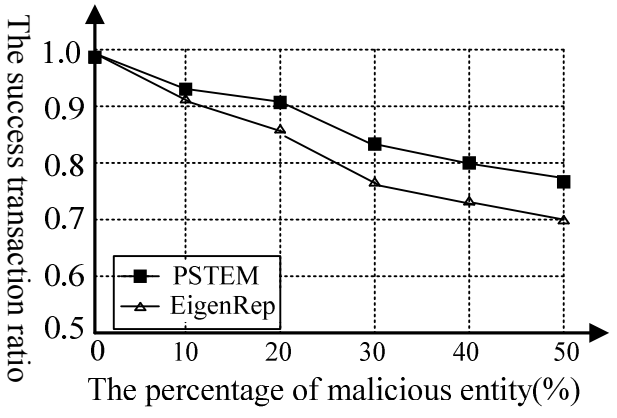

Fig. 2. Transaction success rate comparisons

It can be seen from Figure 2, when there is no malicious node in the system, the success rate of transaction is 95%. With the increase of malicious nodes, the success rate of the transaction dropped significantly in EigenRep model, and when the malicious nodes in the system reaches 50%, the success rate of the transaction is only about 60% in EigenRep model. In simulation experiment of our model, while there are 50% malicious nodes in the system, this model still has a 80% success rate of transaction, experimental results confirm the accuracy and effectiveness of the model.

4 Conclusions

Because the trust relationship between entities is highly subjective, uncertainty, ambiguity, drawing on the trust model of human sociology, according to preference entities interested in, considering the various attributes and characteristics, adopt the fuzzy comprehensive evaluation method to trust the entity evaluation, the introduction

of services similarity algorithm in the Web semantic network, the weighted harmonic and recommendation trust value, in order to improve the reliability of recommended entities, and finally considering the direct trust and recommendation trust of entities, accordingly conclude both meet the current needs of the requesting entity safe and reliable service entities. Finally, simulation experiments performed to verify the validity of model credibility assessment.

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