

A Reputation-Based Trust Model for Peer-to-Peer eCommerce Communities

[Extended Abstract]^{*}

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ABSTRACT

Peer-to-Peer eCommerce communities are commonly perceived as an environment offering both opportunities and threats. One way to minimize threats in such an open community is to use community-based reputations, which can be computed, for example, through feedback about peers' transaction histories. Such reputation information can help estimating the trustworthiness and predicting the future behavior of peers. This paper presents a coherent adaptive trust model for quantifying and comparing the trustworthiness of peers based on a transaction-based feedback system. There are two main features of our model. First, we argue that the trust models based solely on feedback from other peers in the community is inaccurate and ineffective. We introduce three basic trust parameters in computing trustworthiness of peers. In addition to feedback a peer receives through its transactions with other peers, we incorporate the total number of transactions a peer performs, and the credibility of the feedback sources into the model for evaluating the trustworthiness of peers. Second, we introduce two adaptive factors, the transaction context factor and the community context factor, to allow the metric to adapt to different domains and situations and to address common problems encountered in a variety of online communities. We also developed a concrete method to validate the proposed trust model and obtained initial results, showing the feasibility and benefit of our approach.

Categories and Subject Descriptors

K.4.4 [Computers and Society]: Electronic Commerce

General Terms

Design, Security

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Keywords

Peer-to-Peer, Reputation, Trust, Electronic Communities

1. INTRODUCTION

Peer-to-peer (P2P) eCommerce communities are often established dynamically with peers that are unrelated and unknown to each other. Peers of such communities have to manage the risk involved with the transactions without prior experience and knowledge about each other. Reputation systems [1] provide a way for building trust through social control without trusted third parties. Most research on reputation-based trust utilizes community-based feedback that is often a simple aggregation of positive and negative feedback and cannot accurately capture the trustworthiness of peers. In addition, peers can misbehave in a number of ways, such as providing false feedback on other peers. The challenge of building a reputation based trust mechanism is how to effectively cope with such malicious behavior of peers. Another challenge is that trust context varies from community to community and from transaction to transaction. It is important for the trust model to be able to adapt to different communities and different situations. Furthermore, there is also a need for experimental evaluation methods of a given trust model in terms of effectiveness and benefits.

With these questions in mind, we develop PeerTrust, a P2P trust model for quantifying and assessing the trustworthiness of peers in P2P eCommerce communities. A unique characteristic of our trust model is the identification of five important factors for evaluating the trustworthiness of peers in an evolving P2P eCommerce community. A general trust metric is defined to combine these trust parameters in computing trustworthiness of peers. In addition, we validate the proposed trust model with simulations and report the key findings of our initial experiments.

2. THE TRUST MODEL

2.1 Trust Parameters

In PeerTrust, a peer's trustworthiness is defined by an evaluation of the peer in terms of its reputation in providing services to other peers in the past. Such reputation reflects the degree of trust that other peers in the community have on the given peer based on their past experiences. We identify five important factors for such evaluation:

- the feedback in terms of amount of satisfaction a peer obtains through transactions with other peers
- the number of transactions the peer has performed with other peers, a scope factor for comparing the feedback among different peers
- the credibility of peers who submit feedback, addressing the risk of using potentially false feedback to rate peers' reputation
- the transaction context factor, addressing the impact of transaction characteristics (such as transaction size or type) on the trustworthiness of the peers, and
- the community context factor, addressing the impact of community-specific properties on the trustworthiness of peers.

2.2 The General Trust Metric

We define a general trust metric that combines the five parameters in a coherent manner. Let $I(u)$ denote the total number of transactions peer u has during a given period, $S(u, i)$ denote the normalized amount of satisfaction peer u receives from the other peer in its i th transaction, $p(u, i)$ denote the other peer in peer u 's i th transaction, $Cr(p(u, i))$ denote the credibility of the feedback submitted by $p(u, i)$, $TF(u, i)$ denote the transaction context for peer u 's i th transaction, and $CF(u)$ denote the community context for peer u during the period. The trust value of peer u , denoted by $T(u)$, is defined as:

$$T(u) = \alpha * \frac{\sum_{i=1}^{I(u)} S(u, i) * Cr(p(u, i)) * TF(u, i)}{I(u)} + \beta * CF(u)$$

The metric consists of two parts. The first part is a weighted average of the amount of satisfaction a peer receives for each transaction (weighted by the credibility of the feedback source and transaction context). This history-based evaluation can be seen as a prediction for peer u 's likelihood of a successful transaction in the future. A confidence value can be computed and associated with the trust metric that may reflect the number of transactions, the standard deviation of the ratings depending on different communities. The second part adjusts the first part by an increase or decrease of the trust value based on community-specific characteristics and situations. α and β denote the normalized weight factors for the two parts.

This general trust metric may have different appearances depending on which of the parameters are turned on and how the parameters and weight factors are set. The design choices depend on characteristics of communities. We argue that the first three parameters – the feedback, the number of transactions, and the credibility of feedback source – are the important basic trust parameters that should be considered in any P2P eCommerce communities.

2.3 The Basic Metric

The basic metric computes the trust value of a peer u using the three basic parameters by an average of the credible amount of satisfaction peer u receives for each transaction performed during a given period.

Both the feedback and the number of transactions are quantitative measures and can be collected automatically. The third trust parameter – credibility of feedback – is a

qualitative measure and needs to be computed based on past behavior of peers who file feedback. Different approaches can be used to determine the credibility factor and compute the credible amount of satisfaction. For example, one may use a function of the trust value of a peer as its credibility factor so feedback from trustworthy peers are considered more credible and thus weighted more than those from untrustworthy peers. We believe that the study of what determines the precision of credibility of feedback is by itself an interesting and hard research problem that deserves attention of its own.

2.4 Adapting the Metric with Context Factors

The metric may take into account transaction context factor to capture the transaction-dependent characteristics. For example, if a community is business savvy, the size of a transaction is an important context that should be incorporated in the trust metric to weight the feedback for that transaction. It can act as a defense against some of the subtle malicious attacks, such as a seller develops a good reputation by being honest for small transactions and tries to make a profit by being dishonest for large transactions.

Various community contexts can be taken into account to address some of the common problems. For example, the historical transaction history can be built into the metric through community context factor but with a lower weight than recent transaction history to add temporal adaptivity. The problem of lack of incentives to rate or the free riding problem in file sharing communities can be also addressed by building incentives/awards for rating others or sharing files through community context factor. If a trust authority or pre-trusted peers are available in a community, their evaluation can be also built into the metric as community context factor to make the metric more robust against manipulation of malicious peers.

3. EXPERIMENTAL EVALUATION

We built a simulator and performed initial experiments to evaluate PeerTrust approach in terms of its feasibility, effectiveness, and benefits. Some of the findings from our experiments are summarized as follows.

- PeerTrust performs much better than the feedback-only approach when transaction skew increases or malicious behavior (peers submitting false feedback) increases in the community. This verifies the importance of the number of transactions and credibility factor in the trust metric.
- PeerTrust achieves desired temporal adaptivity when historical transaction histories are built into the metric through the community context factor.
- A community where peers use PeerTrust to select peers with highest trust value from potential peers to perform transactions has a higher transaction success rate than a community without any trust schemes where peers select peers randomly from potential peers to perform transactions.

4. REFERENCES

- [1] P. Resnick, R. Zeckhauser, E. Friedman, and K. Kuwabara. Reputation systems. *Communications of the ACM*, 43(12), 2000.