# RepRank: Reputation in a Peer-to-Peer Online System

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## ABSTRACT

Peer-to-peer e-commerce networks exemplify online lemon markets. Trust is key to sustaining these networks. We present a reputation system named RepRank that approaches trust with an intuition that in the peer-to-peer e-commerce world consisting of buyers and sellers, good buyers are those who buy from good sellers, and good sellers are those from whom good buyers buy. We propagate trust and distrust in a network using this mutually recursive definition. We discuss the algorithms and present the evaluation results.

## Categories and Subject Descriptors

H.4 [**Information Systems Applications**]: Miscellaneous

## Keywords

Reputation; E-commerce

## 1. INTRODUCTION

Over the past decade e-commerce, user generated content and recommendations, and social networking applications have become common. As reliance on these applications grow the need for a trust and reputation model has become essential. Feedback in eBay is an expression of reputation. It provides a simple accumulative model for reputation. A positive feedback adds to the score and a negative feedback takes away from it. In this poster, we present a reputation system named RepRank that approaches trust with an intuition that in the peer-to-peer e-commerce world consisting of buyers and sellers, good buyers are those who buy from good sellers, and good sellers are those from whom good buyers buy. RepRank propagates trust and distrust in a network using this mutually recursive definition. The major contributions of our work include: implementing an effective reputation system for a peer-to-peer e-commerce marketplace based on the network of user opinions; incorporating unique features such as distrust propagation, transaction quality, and time-decay of opinions into the system; showing the effectiveness of the system through evaluation with practical use cases.


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## 2. REPRANK

Our reputation system, RepRank, is based on the mechanism that buyers and sellers leave opinions about each others based on their experience in transactions. We model the users and opinions as a directed graph $G = (V, E)$, where each vertex $v_i$ denotes a user. $r_i$ denotes the reputation of user $v_i$. If user $v_i$ has given an opinion $o_{ij}$ towards user $v_j$, an edge $e_{ij}$ exists. A user's reputation is the aggregated opinion of others towards him/her. The key idea of our approach is that an opinion should be weighted by the reputation of who gives it. Those users with prestige reputation are often experienced ones, since the reputations are gained through past transactions. Therefore, the system implies the intuition that experienced users' opinions are more valuable than novices' opinions. Since an opinion is based on a user's experience in a particular transaction, it should also be weighted by the quality of the transaction, i.e., $w_{ij}$. Therefore, the reputation can be calculated as

$$r_j = \sum_{e_{ij} \in E} r_i w_{ij} o_{ij}. \quad (1)$$

The opinion is either positive ($trust_{ij}$) or negative ($distrust_{ij}$). A user can leave multiple opinions towards another. $trust_{ij}$ and $distrust_{ij}$ are set to be the number positive and negative opinions that $v_i$ left for $v_j$, respectively. The scenario of considering only the trust is similar to traditional link-based ranking algorithms for Web pages, e.g., PageRank [1] and HITS [3]. In these algorithms, every incoming link contributes positively to a webpage's importance score. Therefore, we adopt the PageRank algorithm for propagating the reputation along the trust relations. The dampening, splitting and random surfers also apply to the trust propagation in our system. The reputation in Eq. 1 is thus extended to

$$r = \frac{1-d}{|V|} e + dTr, \quad (2)$$

where $T$ is the trust propagation matrix:

$$T_{ij} = \begin{cases} \frac{w_{ij} trust_{ij}}{\sum_j w_{ij} trust_{ij}} & \text{if } e_{ij} \in E; \\ 0 & \text{if } e_{ij} \notin E \end{cases}$$

The reputation based on trust can be computed iteratively. Since the iterations are guaranteed to converge, an arbitrary set of initial reputations can be used. Normally, the initial reputation of all the users are set to be the same, i.e., $r^0 = \frac{1}{|V|} e$.

The distrust between users makes our reputation system different from the linkage network of webpages, where an in-link always adds to the importance of a page. In an online

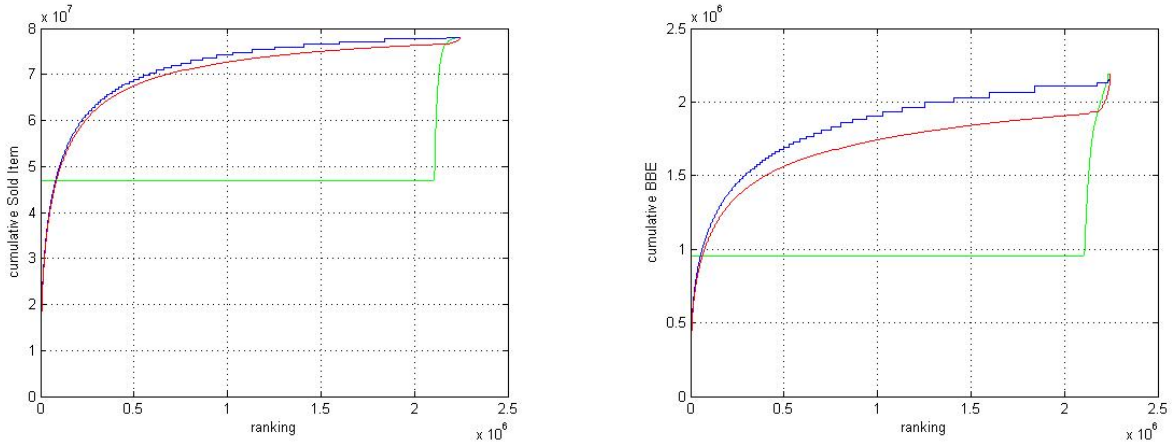


**Figure 1: Cumulative Disputes (a) and Sales of Sellers (b) by Different Rankings. The red curve denotes RepRank, the blue one is the baseline ranking using feedback scores and the green one is using feedback percentages. The curve denotes the cumulative value associated with the top $x$ sellers. For example, in 1(a), a point $(x, y)$ on the curve denotes that the top $x$ sellers sold $y$ items.In 1(b), it denotes that the top $x$ sellers generate $y$ customer disputes (Bad Buyer Experience).**

marketplace, a user leaves a negative feedback to the other party when he/she has a bad experience in the transaction. Similar to the trust relations, the distrust propagation matrix is

$$DT_{ij} = \begin{cases} \frac{w_{ij} distrust_{ij}}{\sum_j w_{ij} distrust_{ij}} & \text{if } e_{ij} \in E; \\ 0 & \text{if } e_{ij} \notin E \end{cases}$$

The negative feedback from a reputable user should affect other's reputation negatively. Properly incorporating the distrust into the reputation system is challenging. In [2], Guha et. al compared various ways of propagating the distrust. Their results show that one-step distrust propagation generates the best results. This conclusion is also intuitive for a peer-to-peer marketplace. Therefore, we choose to propagate the distrust once after the trust propagation, i.e., $r_{distrust} = DTr_{trust}$The final reputation is the sum of reputation scores derived from trust and distrust propagation, i.e.,$r = r_{trust} + r_{distrust}$ Another uniqueness of the reputation system for an online marketplace is that the user opinions are short-term compared to the webpage links, because they pertain to a particular transaction in the past. Therefore, the reputation system should emphasize on the recent opinions. A time-decaying function $f_{decay}(t)$ is thus introduced and applied to both trust and distrust parts of the system.

## 3. REDUCING DISPUTES

As an online marketplace, reducing customer disputes is one of the top goals. It does not only reduce the customer service cost, but also lead to a better shopping experience for customers. Normally, this is achieved by removing the worst sellers based on a ranking from the marketplace, which often means losing sales at the same time. In this use case, we would like a good ranking that enables us to remove the bad sellers without losing a significant amount of sales. Therefore, we evaluate the rankings by both sales and disputes. In Figure 1(a), we can see that the top $2*10^6$ sellers in both feedback score ranking and our ranking made the similar amount of total sales. It is about 2% difference. However, Figure 1(b) shows that these top sellers in our ranking generate for 87.2% of the total disputes, while these top sellers in feedback score ranking is responsible for 96.3% of the total disputes. In other words, if we suspend the worst sellers and only keep the top $2*10^6$ sellers according both rankings, our ranking could reduce about 9% more disputes while keep the sales at the similar amount. The ranking based on feedback percentages is very different from that from the feedback scores and our ranking. Suspensions based on feedback percentage could remove most disputes, but the sales would be totally impacted. Overall, RepRank outperforms the feedback scores and the feedback percentages in reducing the customer disputes.

## 4. CONCLUSIONS

In this poster, we introduce RepRank, an effective reputation system for a peer-to-peer e-commerce marketplace, which is based on opinions between users. RepRank is unique because of incorporating distrust propagation, transaction quality, and time-decay of opinions. We present experimental results that compare our ranking with the current feedback score system. RepRank outperforms the feedback score ranking in reducing customer disputes.

## 5. REFERENCES

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