

Enhancing Reputation Mechanisms via Online Social Networks

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Economic transactions often rely on trust. For instance, sellers usually know more than buyers about items or services offered and could misrepresent them. Without trust, mutually beneficial transactions may not take place, resulting in economic loss [4]. Fortunately, with repeated transactions, reputations [9] can encourage truthful behavior and have been applied to e-commerce in the form of ratings, such as those used by eBay. However, reputation mechanisms can be manipulated through collusion by groups of friends or the creation of false identities. One approach to this problem uses the growing availability of online social networks. These consist of links among individuals indicating various social relationships. Services building online social networks, such as Friendster, LinkedIn, and Spoke¹, have rapidly acquired millions of users and assist them in forming new social or business contacts through those they already have. These existing contacts are either entered manually or gathered automatically, e.g., from email, instant messaging, and the web of trust for decentralized cryptographic keys [6].

We consider two uses of social networks for reputation mechanisms: as an automated aid to identify reputation based on position in the network, and as a filtering tool for users' ratings. The thresholds and weights we describe can be efficiently computed using the network structure.

The first approach uses an individual's position in a social network to compute an implicit reputation [14, 12, 3], without requiring explicit effort on the part of users to rate one another. This approach is useful to the extent that social connectivity correlates with likely behavior.

One way to assign reputation based on social network structure considers each link in the network as an implicit recommendation for the person linked to. Alternatively,

¹www.friendster.com, www.linkedin.com, www.spoke.com

weights can be added to the links by allowing users to privately rate their contacts based on characteristics such as trustworthiness. One can then apply a PageRank algorithm [11] to assign reputations to individuals. Because PageRank is based on the global structure of the network, it is more difficult to spoof than local network properties, as it is not sufficient to have just anyone recommend you, but they need to have high reputation themselves.

A second approach uses ratings produced explicitly by users based on past transactions, but filters them using the social network. For example, the Sporas reputation mechanism [16] reduces the benefit of collusion by only considering a single rating from any other person, no matter how much experience, i.e., number of transactions, they may have. More generally, one can filter based on the receiver's preferences and position of evaluators in the social network. The Regret [13] system uses ratings from the receiver's social group, and the social group of the individual being rated. There are many other ways to use the social network. For example, a user may be encouraged to see a single person giving repeat business to a vendor, but only if that person and the vendor are not too close in the social network. Others may choose to rely more on the number of different raters, from mutually distant parts of the social network. Or one may give higher weights to ratings from one's own friends. Allowing various filters gives flexibility in using social networks.

Using social network structure with reputation makes it more difficult to spoof the system by creating false identities or colluding in groups. False identities would either give themselves away by connecting to their old friends, or remain disconnected, in which case they will have poor social ranking. On the other hand, large-scale analysis of social networks can uncover at least some forms of group collusion. For example, web pages colluding to alter their search engine ranking by linking to one another can be identified and removed if they all have a similar number of links [7]. Alternately, collusion could alter the relative abundance of motifs (small subgraphs), arousing suspicion if it differs significantly from that of social networks in general [10].

If the reputation scores are filtered by excluding explicit ratings from friends and friends of friends, altering reputation scores requires collusion outside of one's social circle, which is more difficult. One could try to thwart the reputation mechanism by deliberately removing links to hide collusion. Removing links risks losing the other benefits for which such networks are constructed, e.g., obtaining busi-

ness referrals or having a high social ranking and enhancing the trust of potential customers. These benefits also encourage users to reveal their social links, even when they otherwise might not be inclined to.

As an example of the potential benefit of using social networks, we analyzed how difficult it would be for two friends to remove a link between themselves and successfully conceal their attempt to collude. We used BuddyZoo data², consisting of 140,181 users of the AOL instant messenger service who submitted their buddy lists to the BuddyZoo service. BuddyZoo is a good example of a subset of individuals from a large social network volunteering information about their social contacts. The resulting network includes links only between users who explicitly registered with BuddyZoo with an average of 9.5 links per user. 9% of the users have only a single connection, and would disconnect themselves from the network if they were to remove it. Of the remaining pairs of users, only 19% could remove their direct link and be at least distance 3 from each other, while all others would remain friends of friends. The scoring algorithm can easily exclude friends of friends, as well as friends, since they comprise only a small fraction of the network. This means that the majority of friends could not effectively conceal their connection because they share friends in common. In fact, the average number of friends shared by two friends in BuddyZoo was four, which means that an average of four additional participants would have to be persuaded to collude. This example illustrates the robustness of social networks against alteration.

Creating online social networks raises privacy concerns of possible misuse, which could inhibit participation (for networks relying on intentional enrollment) or lead to legal barriers to collecting the information (for networks produced as side effects of other activities, e.g., email or phone logs). Privacy protecting methods can reduce these concerns. One such method is using a trusted third party to handle the network data and the associated computations, revealing only the final reputation scores. Alternatively, for those concerned that a third party may eventually misuse or be compelled to reveal the social network, decentralized secure computation [5] could produce the aggregate values without a single party having access to the full social network, though such techniques incur substantial computational cost. NodeRank [12] is a decentralized algorithm similar to PageRank that can assign reputations using a social network. Alternately, one can propagate reputation ratings along the social network, where each agent receives information about potential targets through referral chains [16, 15]. Cryptographic techniques can further improve decentralized algorithms by allowing precise control over the distribution of information among participants without requiring a trusted intermediary.

Using online social networks could improve the effectiveness of the ratings by making it more difficult (though not impossible) to alter the ratings via collusion. As future work, it would be useful to experimentally evaluate how people use such a mechanism, as has been done for other reputation mechanisms [2, 1, 8].

More broadly, social network information could affect more complex mechanisms, such as markets for reputation in which participants can sell their identity to others. Such markets

provide incentives for maintaining reputations even when participants decide to leave their business. In our case, such sales involve changes in the owner's position in the social network, and raise interesting questions of how market incentives may in turn affect the development of the networks.

1. REFERENCES

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²<http://buddyzoo.com>