Providing Cooperative Incentives through the Structure of Social Networks

Radu Jurca and Boi Faltings
Ecole Polytechnique Fédérale de Lausanne (EPFL)
Artificial Intelligence Lab
CH-1015 Lausanne

December 12, 2007

An important trust enabling mechanism governing the trade in the Middle Age was based on the responsibility of an entire community for the activities of its members [Greif, 2002]. In other words, if a trader belonging to the community A cheated on a trader of the community B, the cheated trader was entitled to hold responsible every trader from the community A for his loss. It was later the internal affair of the community A to punish the cheater.

The system worked well because of its locality: the social ties between the individuals belonging to the same community were strong enough to allow credible threats and punishments against cheating, while the encounters between different communities were frequent and profitable enough to make it in the best interest of all communities to maintain a cooperative relationship.

The system based on community responsibility can inspire a new generation of trust enabling mechanisms based on the structure of the social networks readily available today on the internet. The basic idea is the following: *Two individuals should trust one another for a particular online transaction only if there is a path in their social network connecting them. Moreover, if misbehavior occurs, all friends on the social path should be held accountable.*

The cooperative equilibrium is based on three fundamental principles. First, every agent finds it profitable to have a rich social network. Profitable transactions can only occur as a consequence of a path in the social network, and therefore, the more "friends" an agent has, the higher the probability of a transaction, and the higher the expected future reward from being part of the network.

Second, despite the incentive to have many friends, rational agents do not want cheating agents in their immediate neighborhood. Cheaters will generate losses to other agents that will be finally imputed back to their friends. Therefore it is in every agent's best interest to monitor her friends, and isolate cheaters by discontinuing the links in the social network.

Third, the problem of cheap online pseudonyms, so common in internet applications, is solved by an implicit entry tax. Every new identity joining the system must work to rebuild its social network before obtaining some profit.

Moreover, the online social network will most of the time reflect the real social network, so an agent with several identities will have a hard time multiplying her online network. The close connection between the online and the real identity creates credible punishments for cheating: once an agent (online identity) is excluded from the network, the same person will find it difficult to rejoin the network under the same or a different identity.

An important component of this mechanism is to ensure that cheating claims are legitimate. First, every claim must refer to a legitimate transaction. Cryptographic mechanisms can be used to create unique, verifiable, non-repudiable transaction identifiers that can be later used in claims. Second, cheating claims must trace back the path(s) of friends that created the chains of trust. This can also be the result of a pre-contract hand-shaking protocol, where the existing paths between a source and a destination at the time of a transaction are recorded and signed in a cryptographic proof. Third, proper incentives must make it in the best interest of the agents to report honestly a cheating transaction. For that the mechanisms of Jurca and Faltings [2007b] or Jurca and Faltings [2007a] may be adapted to make honest reporting a Nash Equilibrium.

Incentive mechanisms based on the structure of social network may have a variety of practical applications:

- control the quality of information
- securely implement viral marketing and distributed advertising mechanisms
- implement distributed payments and financial transactions
- foster trust in peer-to-peer applications and P2P commerce
- augment existing trust mechanisms for distributed, P2P auctions like eBay.

References

Avner Greif. Institutions and Impersonal Exchange: From Communal to Individual Responsibility. *Journal of Institutional and Theoretical Economics (JITE)*, 158(1):168–204, March 2002.

Radu Jurca and Boi Faltings. Collusion Resistant, Incentive Compatible Feedback Payments. In *Proceedings of the ACM Conference on Electronic Commerce (EC'07)*, pages 200–209, San Diego, USA, June 11–15 2007a.

Radu Jurca and Boi Faltings. Obtaining Reliable Feedback when Clients can Commit to Report Honestly. *Journal of Artificial Intelligence Research*, 29, 2007b.