Recommending Users in Social Networks by Integrating Local and Global Reputation

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Introduction

Automatically suggesting the trustworthiness a user should assign to the other OSN members is an important task in OSNs.

Global reputation models are based on feedbacks.

- (-) Malicious and fraudulent behaviors, which potentially makes unreliable the feedbacks themselves.

We propose to integrate global reputation models with a local reputation, computed on the user ego-network.

Experiments shows that

- the usefulness of global reputation is significative only when ego-networks are small in size.
- Integrating global and local reputation allows to predict trust with a very high level of precision.

Ego network

We represent an OSN S as a directed network $G_S = \langle N, A \rangle$, where N is the set of nodes and A is the set of arcs.

Each node $n \in N$ is a user $u_n \in U$, each arc $c \in A$ is a pair (a, b), with $a, b \in N$, i.e. "trust link" between u_a and u_b (i.e. a trusts b).

Ego-network of a user u is the sub-graph $G_u = \langle T, P \rangle$

- T is the set of nodes $n(k) \in U$ such that there exists a path $n(u) \rightsquigarrow n(k)$;
- P is the set of the arcs belonging to the paths existing between $n(u)$ and $n(k)$, for each $k \in T$.

Local reputation measure $\lambda(u, v)$

Given a ego network G_u, we define

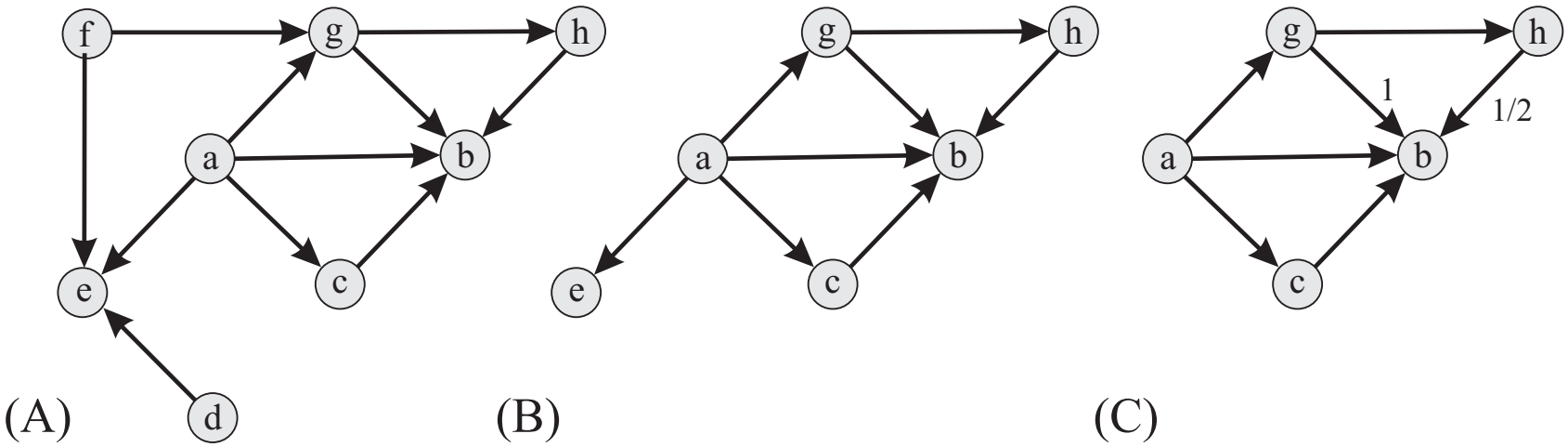
1-Local Network $L(u, v) = \{z \in N : z \in G_u \wedge \exists(z, v) \in G_u\}$. I.e. all the nodes z in G_u such that z trust v.

2-Local reputation $\lambda(u, v)$, i.e. how much, in overall, the users belonging to the ego network of u trust v:

$$\text{Let be } s(u, v) = \sum_{k \in L(u,v), k \neq u,v} \left\{ \frac{1}{2^{l_{u,k}-1}} \right\} \qquad l_{u,k} := |u \rightsquigarrow k|$$

$$\text{then } \lambda(u, v) = \frac{s(u, v)}{\max\limits_{z \in U, z \neq u,v} s(u, z)}$$

Local reputation measure $\lambda(u, v)$



(B) The ego-network of node a, (C) nodes contributing to $\lambda(a, b)$.

- Computing $\lambda(a, b)$ means considering nodes g,c and h, then $\lambda(a, b) = 1$.

- Computing $\lambda(a, h)$ means considering only node g as contributor, then $\lambda(a, h) = 1/2.5 = 0.4$.

Global trust

Users $u \in U$ can make *actions* a_u which can be evaluated by the other users $k \in U, k \neq u$ by means of *feedbacks* $f(k, a_u^i)$, e.g.:

- EPINIONS or CIAO, on which users provide reviews of some items, and the other users provided the helpfulness of the reviews (i.e. reputation).

We define a *global reputation* of a user u which performed p actions a_u^i as:

$$\gamma(u) = \frac{\sum_{i=1,..,p} \sum_{k \in U, k \neq u} f(k, a_u^i)}{p \cdot \|U\| - 1}$$

Suggesting trust

Our approach for suggesting/predicting the trust of u to v is to combine local and global reputation:

$$\sigma(u, v) = \omega \cdot \lambda(u, v) + (1 - \omega) \cdot \gamma(v)$$

$$st(u, v) = \begin{cases} 1 & \text{if } \sigma(u, v) > \tau \\ 0 & \text{otherwise} \end{cases}$$

Where τ is a suitable threshold.

Tuning the prediction model

To find optimal values for ω (weight) and τ (threshold), we examine a training-set $TR = \langle U*, A*, F*, T* \rangle$:

- $U* \subset U$ is a subset of the users of S;
- $A* \subset A$ actions performed by the users of $U*$;
- $F* \subset F$ feedbacks provided within U^* for the actions in $A*$;
- $T*$ contains the trust values $t(u, v)$, for all $u, v \in U^*$.

$$\epsilon(\omega, \tau) = \frac{\sum_{u,v \in U, u \neq v} |st(u, v) - t(u, v)|}{(\|U\| - 1)^2} \quad (1)$$

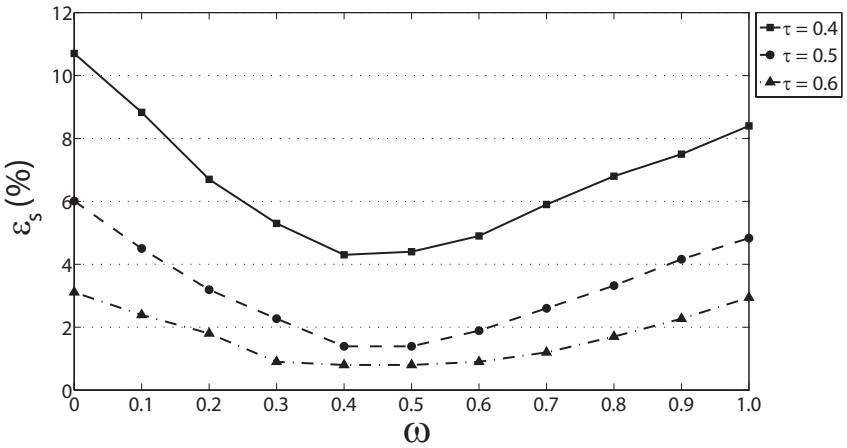
Have to look for ω^* and τ^* minimising $\epsilon(\omega, \tau)$, i.e.:

$$\epsilon(\omega^*, \tau^*) = \min \frac{\sum_{u,v \in U, u \neq v} |st(u, v) - t(u, v)|}{(\|U\| - 1)^2} \quad (2)$$

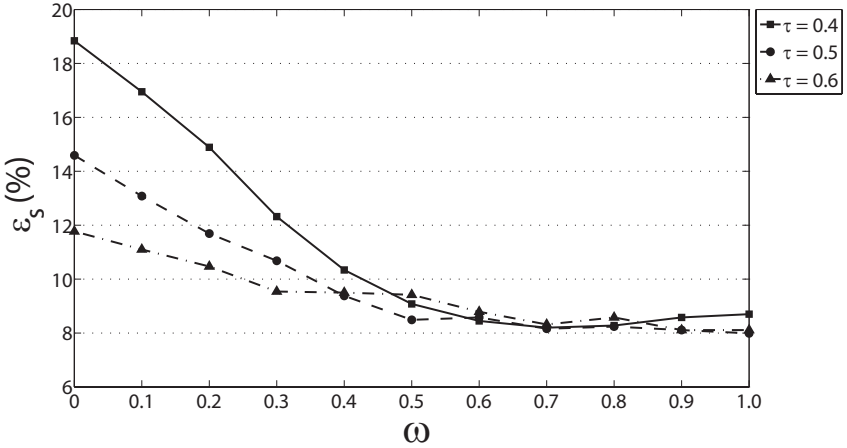
Experiments

Real data extracted from the well-known CIAO social network.

We examined how the global error $\epsilon(\omega, \tau)$ depends on the mean value $\|L(u, v)\|$, say ρ_u.



(A) $\rho_u = 733$



(B) $\rho_u = 14599$.

Experiments

ρ_u	ω^*	E	E ($\omega = 1$)
733	0.5-0.6	1%	5%
2560	0.5-0.6	2%	6%
7360	0.6	5%	6%
14599	1.0	8.5%	8%

$\rho_u = 733 - 2560$: for this users it is important to merge both local and global reputation in equal measure.

- the local ego-network is not sufficiently large to suggest a correct trust without the help of the global reputation.
- Note that for $\rho = 2560$, the difference from using high values of ω is less important.

$\rho_u = 7360 - 14599$: users having very high values of ρ_u, the local reputation approximates the global one.

Conclusions

The proposed model aims at integrating local and global reputation in an OSN.

- ω is the importance given to local reputation;
- τ is the reputation threshold under which a user is considered unreliable;
- ρ represents the dimension of the user ego-network.

Some experiments have shown that the global reputation is relevant only for those users having an ego-network small enough.

Instead, in the case of users having large ego-networks, local reputation is enough to predict trustworthiness with a very high precision.

Thank you!