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INCORPORATING USER-BASED TRUST AND TAG-BASED INTEREST FOR COMPUTATIONAL TRUST IN SOCIAL NETWORK

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Abstract

In social media, trust level among users not only depends on their interaction experience but also on the expertise, which exposes user's interest by tags on topics. In this paper, we first present a model of computational trust among users based on incorporating their experience-based trust and trust with expertise level based on tag posted by users. Then, based on the computation model, we propose an algorithm for computing trust in social network.

1 Introduction

Virtual networks such as forums, blogs, wiki, social networks, etc. have facilitated for users to interact with one another. By means of interaction, they may share information or opinions, exchange ideas, make friendship etc. In social network, users can utilize their own tags to annotate and organise items for seraching or sharing. They also make use of tags for showing their viewpoint

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or opinions. Such a tag is a kind of metadata composed of keywords or terms, which is used to assign to a piece of information such as an bookmarks, article title, comments of digital image etc., to describe an item in their viewpoints. These tags have contributed to constructing real world applications such as recommender systems, searching engine, collecting customer opinions ([1] [2] [7] [8] [9] [10] [11]).

In such communities, trust has become crucial for belief among partners when sharing or posting their messages and it has attracted increasing attention in distributed computing ([12] [5] [8]). And there are various models of computational trust proposed in literature ([4] [6] [5]). However, such computation approaches are mainly based on interaction among partners rather than the semantics of messages communicated in the network.

The purpose of this paper is to describe a computational model of trust by incorporating an interaction-based trust and interest-based expert level of users in social media. The former is based on temporal interaction given by Nguyen et al., [5] and the latter is constructed from user's interests described by tags and classified in topics. The remainder of this paper is organized as follows. Section 2 describes preliminaries for presenting the following section. Section 3 presents a computational model of incorporation of trust and user's expert level based on his interests. Section 4 is a conclusion.

2 Preliminaries

This section presents some concepts and notations, which are basis for the presentation in the next section.

- Each user in social media may be considered as autonomous entity in the system. Let $\mathcal{U} = \{u_1, \ldots, u_n\}$ be a set of all users.
- U_{uv} is a set of all interaction among u and v and $\mid U_{uv} \mid$ is a number of their interaction.
- Tag is a brief piece of information dispatched from some user i to make a description or post information/idea/opinions on an item such as a paper, a book, a film, a thing and so on.
- A knowledge base (KB) typically consists of a set of concepts $C_1, ..., C_n$, a set of instances I_i for each concept C_i, and a set of relationships $R_1, ..., R_m$ among the concepts. A concept is considered as a topic.
- Intuitively, when a user is interested in some topic t, he is willing to dispatch a tag about items on it. From such tags, we can construct a classification of all tags into set of topics (Refer to [9] for more detail). Suppose that $\mathcal{T} = \{t_1, \cdots, t_n\}$ is a set of such topics.

Definition 1. *A trust is a function* $t : \mathcal{U} \times \mathcal{U} \rightarrow [0,1]$*, in which* $[0,1]$ *is an unit interval of the real numbers. The value* $t(u,v) = \alpha$ *means that* u *(truster) trusts* v *(trustee) with respect to the degree* α*.*

Denote $w = (w_1, w_2, ...w_{|U_{uv}|})$ to be the weight vector, in which $\mid U_{uv} \mid$ is a number of interaction among users u and v, such that $\sum_{k=1}^{|U_{uv}|} w_k = 1$ and $w_{k_1} \geqslant w_{k_2}$ if $k_1 < k_2$. The vector is used to describe the weighted evaluation of temporal trust. The constraints $w_{k_1} \geqslant w_{k_2}$ if $k_1 < k_2$ illustrates a fact that the recent evaluation of a user u on a user v is more important than the previous ones. The construction of the weight vector may be based on Regular Decreasing Monotone (RDM) function. **Algorithm 1** on computing experience trust is proposed by Nguyen et al., [5], in which $generateW(k)$ is a function generating the weight vector w of size k.

Definition 2. *Experience trust of user* u *in user* v*, denoted* $trust_{exp}(u,v)$*, is defined by the formula*

$$trus_{exp}(u,v) = e_{uv} = t_{uv} * w = \sum_{k=1}^{|U_{uv}|} t_{uv}^k * w_k \tag{1}$$

where t_{uv} *is the vector of temporal interaction trust of user* u *in its partner* v *and* w *is the vector of weighted interaction.*

Algorithm 1 Experience trust of a on u via interaction

Input: The set of interaction of users a and u
Output: the trust of a on u, $calculateTrust_{exp}(a,u)$.

for all user i in the system **do**
  if there is a new transaction k with a partner j **then**
    $t_{ij}^k \leftarrow$ 0 or 0.5 or 1 // 0: negative; 0.5: neutral; 1: positive
    $t_{ij} \leftarrow t_{ij} \cup t_{ij}^k$ // add t_{ij}^k into t_{ij}
    $t_{ij} \leftarrow sort(t_{ij})$ //re-sort t_{ij} on descending of time
    $w \leftarrow generateW(k)$ //generate the weight vector w of size k
    $e_{ij} \leftarrow \sum_{h=1}^{k} t_{ij}^h * w_h$ //update the experience trust
  end if
end for
return $trust_{exp}(a,u)$

3 Incorporating the Experience Trust and Interest-based Expert Level

This section presents definitions of concepts and algorithms for computing incorporation trust.

Definition 3. *Suppose that n_t^u is the number of tags u has dispatched in some topic t. Then the level of interest of u on topic t is defined by the following formula*

$$interest_{topic}(u,t) = \frac{n_t^u}{\sum_{h \in \mathcal{T}} n_h^u} \tag{2}$$

Definition 4. *Suppose $interest_{topic}(u,t)$ is the level of interest of u on topic t. Then the level of expert of user u on the topic t is defined as follows*

$$expert(u,t) = interest_{topic}(u,t)$$

Algorithm 2 Trust of a on u of topic t

Input: The set of topics $\mathcal{T} = \{t_1, t_2, ..., t_n\}$ and the set of users $\mathcal{U} = \{u_1, u_2, ..., u_m\}$ with tags
Output: the trust of a on u of topic t, $calculateTrust_{topic}(a,u,t)$.

1: $\mathcal{T} \leftarrow classifier(tags, Topic)$ //Classifying tags into topics
2: **for all** t in $\mathcal{T}$ **do**
3: **for all** $v \in \mathcal{U}$ **do**
4: $n_t^v \leftarrow numberOfTags(v,t)$ //Number of tags v post on topic t
5: **end for**
6: $expert(u,t) \leftarrow \frac{n_t^u}{\sum_{h \in \mathcal{T}} n_h^u}$
7: **end for**
8: $trust_{topic}(a,u,t) \leftarrow trust_{exp}(a,u) \odot expert(u,t)$
return $trust_{topic}(a,u,t)$

Based on the trust among users via experience and expert level of a user on some topic t, we can construct a trust of a on u of topic t as follows.

Definition 5. *A function $f : [0,1] \times [0,1] \to [0,1]$ is a topic-trust iff it is a increasing monotonic corresponding to each variable.*

Proposition 1. *The following functions $f : [0,1] \times [0,1] \to [0,1]$ are topic-trust ones:*
(i) $f(x,y) = x \times y$
(ii) $f(x,y) = max(x,y)$

Definition 6. *Supose that* $trust_{exp}(a,u) = \alpha$ *and* $expert(u,t) = \beta$*, then the trust of* a *on* u *of topic* t *is defined by the following formula:*

$$trust_{topic}(a,u,t) = \alpha \odot \beta$$

where $f(\alpha,\beta) = \alpha \odot \beta$ *is a topic-trust function.*

It is easy to prove the following propositions.

Proposition 2. *If* $expert(u,t) =< expert(v,t)$*, then for all* a*,*

$$trust_{topic}(a,u,t) =< trust_{topic}(a,v,t).$$

Proposition 3. *If* $trust_{exp}(a,u) =< trust_{exp}(a,v)$*, then*

$$trust_{topic}(a,u,t) =< trust_{topic}(a,v,t).$$

Proposition 4. *Supose that* $\alpha = trust_{exp}(a,u)$ *and* $expert(u,t) = \beta$*, then* $trust_{topic}(a,u,t) = w_1 * \alpha + w_2 * \beta$*, where* $w_1 + w_2 = 1$*, is also topic trust of* a *on* u *of* t*.*

Based on Steps for computing incorporation trust in the social network is given in **Algorithm 2**.

4 Conclusions

In this paper, we have introduced a model of incorporation trust, which integrates the traditional computational trust based on experience of direct interaction and expert level with semantics based on tags in social network. However, the level of expert in this paper is based on a classification of tags into topics. A question is if the computation of incorporation trust depends various classification. The issue needs to be investigated furthermore. We are currently considering an experimental evaluation with other models on computing trust in social network. The research results will be presented in our future work.

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