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New Graph Based Trust Similarity Measure

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Abstract

Trust network in social networks can be considered as graph which trustors and trustees are graph vertices and edges present trust between them with measured values. To evaluate trust between trustors and trustees there is some similarity measures to measure similarity between trustors together or trustees together and then by using evaluated values predict trust value between them. Similarity measure has important effect on final accuracy. In this paper we propose graph based similarity measure. Similarity between two users is computed by connection between them on graph then this computed similarity used with k- nearest neighbors method to evaluate(predict) trust between users. To the best of our knowledge this is the first work introduces graph based similarity measure, empirical results on two real datasets show accuracy of predicted trust using proposed similarity measure outperforms accuracy of method without it.

Keywords: *trust, similarity measure, graph based, trust evaluation.*

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1 Introduction

Nowadays evaluating trust between users in social networks draw attention,trust evaluation aims to infer trust value between trustor and trustee in the social networks, trust inference has large impact in some applicaton including ecommerce, mobile ad hoc network and etc[1]. However what trust is and how trust propagates across social network is a problem that does not have one-for all solution. As network topology and user behavior change among networks, every network reqires particular analysis [2].

Trust evaluation is ususally based on users' social connection and graph view of social network edges representative for connections and value on edges show trust amount between two users. Each user can has connection with many other users in network with different trust values [3].

Same as collaborative filtering recommender systems in trust inference we can consider two method for computing similarity:

1- Trustee based similarity
2- Trustor based similarity

In the first method the similarity between each two trustee pairs will be computed and in second one similarity between trustor pairs will be computed. In first method the model determines k most similar trustees that have same rates to active user and considers them as its neighbors then based on neighbors' rate computes active user rate but in second method instead of of computing similarity between trustees we consider on trustors as an active user and find k most similar users who have most similar belief to the active user and then predict trust amount.

In this work we evaluate trust using two mentioned methods and to the best of our knowledge this is the first attempt to evaluates trust by these methods. The proposed method experimented on two real trust datasets: Epinions and FilmTrust, results show prediction using our proposed similarity measure outperfoms trust evaluation without these methods. In rest of this article, we investigate related work in section 2, introduce our proposed method in section 3 and represent experimental results and in section 4.

2 Related Work

Many trust inference methods exists which evaluate trust in social networks based on different measures. For example Adali et al [4] present quantifiable measure of trust which can be determined from the communication behavior of the actors in a soical communication network they detect statistically realizations fro user behavior in social network to determine trust like behavior called Who-Trust-Whom. In another work W.Jiang et al [5] propose trust framework for large online social netorks discover short trusted paths bsed on trusted acquaintance chains this graph based framework searches neighbors in each stage of search algorithm.

Same as trust network in recommender systems also similarity measures is important concept it has been used both item based and user based collaborative filtering to find the capable neighbors for active user. L.H. Son [6] defines mathematical fuzzy recommender system uses fuzzy similarity degree and proposes hybrid user based fuzzy collaborative filtering method that integrates the fuzzy similarity degrees between users, based on the demographic data with the hard user-based degrees calculated from rating histories into the final similarity degres. A. Beutel et al [7] model the structure of items' rating suitable for non-gaussian shape of the distribution they cocluster users and items to improve the accuracy of the model, they use Gibbs sampling to make model accurate in prediction and robust to fraud. In different work N.B. Mannan et al [8] uses multi layer feed forward artifitial neural network as similarity measurement function and suppose similarity between two users as function with set of adaptive weights and attempt to train a neural network to optimize the weights.

By the way all of these works are some attempts to define the efficient and robust measures or stable solution to evaluate trust but

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as mentioned above there is no total solution for all trust networks because some parameters such as network topologie, users behaviors, users relationships, network model grid and etc are different in each network and have ignorable impact on trust definition in each network.

3 Proposed Method

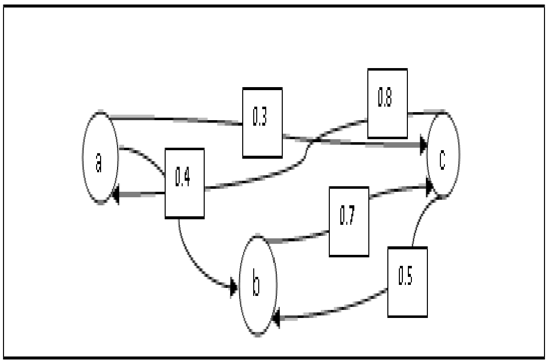
Trust networks suffer from sparse data problem so by considering network topology as graph we can alleviate this problem, for this purpose we can use indirect links between trustors and trustees in grph determines they trust together or not but this method only consider trust as binary concept (trust and distrust) and doesn't present the amount of trust. However in our method we use vertices of graph (between trustors and trustees) to evaluate amount of trust between users in network by using concept of maximum link.

To build graph we suppose t_{ax} have value in [0,1], means have value v if trustor a evaluate trustee b and Ø if trustor a doesn't know trustee b. We consider a network with three users such as below table:

Table. 1. Sample network with three user

	a	B	C
A	1.0	0.4	0.3
B	0	1.0	0.7
C	0.8	0.5	1

Each vertices in network graph conects trustor to trustee, we can present above sample network in graph view as below:



Figur1: Graph G for sample network with three users.

As above we see, network represented by graph G = <V,E> which V is set of vertices and E is set of edges as you can see each node can plays two rules in graph trustor and trustee but graph is not bipart graph unlike recommender systems graph which nodes are in two groups: users and items. Weight of ech edge is determined by w_{ab} where if a and b are connected it has value between 0 and 1 and get value 0 otherwise.

We define C = $\{c_{ab}\}$ is weighted matrix that representing graph G(i = 1,2,..., N+M; j = 1,2,..., N+M).

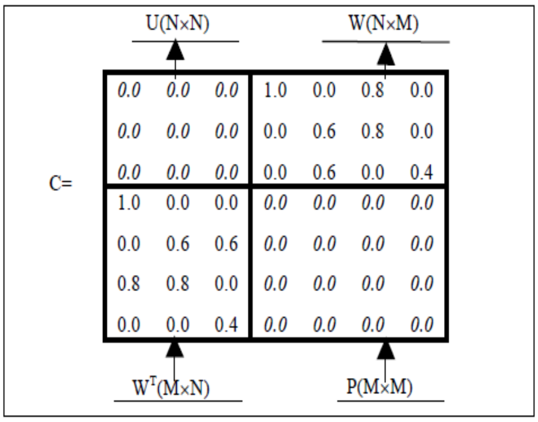
Then the square matrix C will divide into four parts according to formula (1).

$$C = \begin{pmatrix} U(N \times N) & W(N \times M) \\ W^T(M \times N) & P(M \times M) \end{pmatrix}$$

Formula1: Square matrix C

U(N*N): relations between trustors
P(M*M): relations between trustees
W(N*M): relations between trustors and trustees
W^T(M*N): transpositive of W(M*N)

Similarity between users computed by weight of paths between them so our trust evaluation method can be considered as path finding algorithm. The similar vslues between two users will be filled into the matrix U(N×N), the similar values between two items will be filled into the matrix P(M×M), the suitable values of users with items will be filled into the matrix W(N×M) and W^T(M×N). Specific contents of each approach methos will be represented in next sections of the article.



Figur2: Weighted matrix of network

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Weight of each path with length 1 is its edge value but weight of paths with 2 or more edges is linear combination of weights of each edge. For example b to a path weight is equal to 0.7×0.8 which is the combination of weights of each edge.

When the items set $P_{ab} = \emptyset$ is co-evaluated by both user a and user b, correlative measures will not determine similarity between user a and user b. In general, defining $U^L(N\times N)$ is sum weights of paths having length L from the user vertices $a\in U$ to the vertices $b\in U$ on the graph G ($a = 1,2,\ldots,N$; $b = 1,2,\ldots N$). since sum weights of each path having length L is calculated by multiple weights of edges, so total weights of paths having length L from one user vertices to other user vertices on the graph G.

$$U^L = \begin{cases} W.W^T & \text{if} \quad L = 2 \\ W\,W^T\,U^{L-2} & \text{if} \quad L = 4,6,8,\ldots \end{cases}$$

Formula2: Sum weights of paths with length L

```
Input:
      The weighted matrix c shows graph G = <V,E>.
      a∈U is a trustors need prediction result.
      k is the number of neighbors for each trustor.
Output:
      Tax (trust rate of trustor a to new trustee x).
Step1. Compute Similarities between two trustors
      Set L = 2 as initial path length
    Do
       If( L = 2) {
          U^L = WW^T
          }
       Else if(L is equal to another even numbers){
             U^L=WW^TU^L-2
          }
    Until(U^L_ab~=0)
```

Algorithm1: Trustor grph based similarity algorithm

4 Experimental Results

To evaluate our algorithm we make emprical experiments on two real word datasets: FilmTrust and Epinions. The first one consists of 1508×2071 columns and rows, second one is 71002×104356, but trust values of these datasets are only 0 and 1 we convert them to values in [0,1] with randomly considering 1 values are equal to numbers in [0.6,1] and 0 values are equal to [0,0.5]. we consider 20 users as active trustors in first experiment and increment that sequetially in next experiments from 30 to 80 users and suppose k=10. From each dataset in each experiment at first consider 70 percent of users' data as training data and 30 percent for test and then in nesxt step consoder 80 percent as train data and 20 percent as test data. Experimental results show that our method perform better results by increasing acitve trustors and changing percent of train and test data nearly has same results.

We evaluate the results by computing RMSE(Root Mean Square Error) of method in each step the achieved results are shown in the below tables:

Table 2. Graph based similarity RMSE

a) RMSE of proposed method by 70% of active users' data as training and 30% as test

20 active users	30 active users	40 active users	50 active users	60 active users	70 active users	80 active users
0.693	0.651	0.612	0.584	0.573	0.569	0.565

b) RMSE of proposed method by 80% of active users' data as training and 20% as test

20 active users	30 active users	40 active users	50 active users	60 active users	70 active users	80 active users
0.690	0.648	0.609	0.580	0.569	0.562	0.557

5 Conclusion and Future Work

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In this paper we propose the graphical implementation for trust evaluation in social network. Grphical implementation can easily implemented on datasets and alleviates the data sparse data problem by using indirect trust inference by path finding in graph. We represent mathematical graph based similarity measure to find k nearest neighbors of active trustors. Experimental results show robustness of our method when number of active users increasing. For future work we aim to consider diffrent weight for each co-rated trustees between two trustors to find neighbors more accurately for active trustors and get better results in trust value prediction between two trustors.

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