A Ranking

Here we

and finding the minimum distance of the various nodes in the search result from the searching node. Let d_{ab} be the shortest distances between nodes a and b, then proximity p_{ab} is calculated as

$$\text{L}_{\text{ô õ}}\text{L}\ \frac{\text{s}}{\text{@}_{\text{ô õ}}}$$

2. Similarity: Social networks provide users a platform for interacting with other users who share similar interests, listen to the same kind of music, read books from the same author, follow the same sport, share the same hobbies, etc. On a social network all these details are captured in the user profiles. When a user issues a search for another user, a user who is more similar to the searching user is likely to be a more relevant result in comparison to a user who is less similar. We define a user profile of user a as

$$\text{2}_{\text{ô}}\ \text{L}\ \text{<G á H á I=á J å}$$

where k, l, m, n … are the interests. Similarity S, between two nodes a and b in a list of search results with n nodes is defined as

$$\text{5}_{\text{ô õ}}\text{L}\ \frac{\text{% = N @ E J:2}_{\text{ô}}\text{= Hê E 2}_{\text{õ}}\text{; U}}{\text{% = N @ E J:2}_{\text{ô}}\text{= Hë E 2}_{\text{õ}}\text{P Uë 2}_{\text{ö}}\text{ë å ë}_{\text{ä}}\text{;2}}$$

3. Interaction: Social networks provide users differen

$$\text{N}^{\text{Íô}}_{\text{ôõ}} \;\text{L}\; \text{s} \;\text{F}\; \frac{\text{S}^{\text{Íô}}}{\text{R}_{\text{â}} \;\text{F}\; \text{P}^{\text{Íô}}_{\text{ôõ}}}$$

where t_o is the time instanceat which the searchquery wasissued,t_{ab}^{Ti} is the time instance of the most recentinteractionbetweenusera andb of type T_i andwindow sizew^{Ti} is defined as

$$\text{S}^{\text{Íô}} \;\text{L}\; \bullet\; \text{ƒ}\; \text{š}_{\text{â}}\; \text{K}\; \text{P}^{\text{Íô}}_{\text{ôõ}}\text{á}_{\text{â}}\; \text{F}\; \text{P}^{\text{Íô}}_{\text{ôö}}\text{á}_{\text{â}}\; \text{F}\; \text{P}^{\text{Íô}}_{\text{ô×}}\text{á}\; \text{å}\; \text{ä}_{\text{â}}\, \text{F}\text{á}\; \text{P}^{\text{Íô}}_{\text{ôá}}\text{o}$$

where usersb, c, d, …,n are the searchresults of the query. The frequencyand recency metricsare then usedto defineinteractioni of type T_i betweentwo usersa andb as

$$\text{E}^{\text{Íô}}_{\text{ôõ}} \;\text{L}\; \text{Ù}^{\text{Íô}}_{\text{ôõ}}\text{N}\text{E} \;:\; \text{s} \;\text{F}\; ;\text{B}^{\text{Íô}}_{\text{ôõ}}$$

where 0 ≤ α ≤ 1. α is defined as the relative importance of recencyin comparisonto frequencywhen quantifyinga particularinteraction.

Theweightedinteractionmetric I betweentwo usersa andb isdefinedasthe weightedsum of the three typesof interactions(comment,share,like) as

$$\text{+}_{\text{ôõ}}^{\text{`}} \;\text{L}\,(\; \text{Ú}^{\text{Í}}_{\text{ôõ}}\text{P}\text{E}\; \text{Û}^{\text{Í}}_{\text{ôõ}}\text{E}\; \text{Ü}^{\text{Í}}_{\text{ôõ}}\text{E}$$

where β + γ + δ = 1. Hereβ, γ and δ definethe percentageimportanceof the three typesof interactioni.e. comment,shareandlike in the overallinteractionmetric I.

The Association Function

Oncethe three metrics proximity, similarity and interaction have been defined, the next step is to define the associationbetween the user and the searchresults basedon these three parameters. Associationcapturesthe effect of the three metricsin questionand returns a compositevaluewhich describeshow closelythe useris associatedwith eachof the searchresults.Asdiscussedearlier, the importanceof eachof thesemetrics may vary accordingto the nature of the online socialnetwork. Therefore,weights are defined to give different weightsto eachof and

$$J_5\ E\ \ _6JE\ \ _7J\ L\ \ s$$

Therefore, μ_1, μ_2 and μ_3 can be defined as the percentage importance of proximity, similarity and interaction in calculating the association according to the nature of the social network. For example, in social network catering to football fans, where similarity is more important than proximity and interaction, μ_2 may have a higher value, while on a social network for classmates, proximity is more important, so, μ_1 may have a higher value.

The Rank Function

The ranks of the search results are subsequently obtained by sorting the results by the weighted association values. The search with the highest weighted association value is given rank 1, the search result with the second highest weighted association value is give rank 2, and so on, until the search result with the lowest weighted association value is given rank n.

Algorithm for Computing Search Ranks

The proposed algorithm is a ranking algorithm and, therefore, allows different search algorithms to be used to identify the unranked search results. Once the unranked search results are obtained, they are then ranked using the proposed algorithm. The association function is central to the calculation of the ranks of the search results.

We consider that n potential search results are returned by the searching algorithm for a given query. Once this list is obtained, the next steps are to calculate the association and then rank the list on the basis of the association values.

Pseudo Code:

```
Initialize the network N, searching user s, search query q
ranked_search_results(N, s, q)
begin
    search_results[1..n] ← search(q, N)
    ranked_list[1…n] ← compute_ranks(s, search_results[1..n])
end
compute_ranks(s, search_results[1..n])
begin
    window_sizes ← get_window_sizes(s, search_results[1..n])
    common_interests_cardinality ← get_common_interests_cardinality(s, search_results[1..n])
    association[1…n] ← compute_association(s, search_results[1..n], window_sizes,
    common_interests_cardinality)
```

```
ranked_results[1…n] ←
```

```
        similarity ← $interests_s$ ë $interests_i$
end
get_interaction(s, i, window_sizes)
begin
        frequency ← 1 – 1/interaction_volume(s,i)
        $recency_{comment}$ ← 1 – $window\_size_{comment}$/recency_of_comment(s,i)
        $recency_{share}$ ← 1 – $window\_size_{share}$/recency_of_share(s,i)
        $recency_{like}$ ← 1 – $window\_size_{like}$/recency_of_like(s,i)
        recency ← $\boldsymbol{\beta}$ $recency_{comment}$ + $\boldsymbol{\gamma}$ $recency_{share}$ + $\boldsymbol{\delta}$ $recency_{like}$
        interaction ← $\boldsymbol{\alpha}$ recency + (1 – $\boldsymbol{\alpha}$) frequency
end
```

Lemma1: 6EIA %KILHATEPU L 1:J;

Proof: Time complexity of interest is that of the function compute_ranks. We assume that the sorting algorithm used has a worst case complexity of n log n.

```
Proof:
        begin
                get_window_sizes                              n steps
                get_common_interests_cardinality Étqes
c g e t _ w i n w 8 T c t j
```

The Framework

We propose to model a social network in the form of a graph, where the nodes correspond to the users and the edges correspond to the friendship between them. We have considered a simple network shown in Fig.1 where a user John issues a search for another user Maria.

The search query will return Maria a, Maria b and Maria c. The task now is to rank these results according to relevance to user John.

Some illustrative results of the proposed ranking algorithm for different weights are mentioned along with a comparison of search results from other popular social network sites and recent

Scalability

The proposed algorithm was tested for scalability by varying the number of potential search results and measuring the time required for calculation of association function for the same. Table 3 shows selected results of the simulations. In conformity with the time complexity of the algorithm, the time for execution with different number of potential search results was found to increase almost linearly. Figure 2 shows the plot of execution time versus the number of potential search results.

The important insight from this analysis is that calculation of the association function for as many as 1 million records is 3188 smithies means that if we assume a particular user to have 1000 contacts in his/her network, we can calculate the association of the user with other users up to two hops away. This can have important implications for the usefulness of the association function. Some likely usages to which the association function can be applied are discussed in a section below.

No. of Potential Search Results	Execution Time (ms)

Figure2

Observations

The nature of the rank function

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4. # Ðr á ;s

Weighted association,A, is the weighted sum of proximity, similarity and interaction such that

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: # :Ðá ;s

Discussion

The results from the proposed algorithm show that depending on the values set for the different parameters namely, α, β, γ, δ, μ_1, μ_2 and μ_3, suitable results can be obtained. The nature of a particular social network will dictate what values must be set for each of these parameters.The advantages of the proposed algorithm include:

a) Intuitiveness The algorithm uses intuitive

Usein SocialNetworks

It is a commonpracticeto suggestconnectionsto a useron socialnetwork websites.Theutility of this functionality in a socialnetwork is derivedfrom its ability to suggestuseful connectionswhich might existin a user’sextendednetwork and may havesimilar interestsas those of the user. The associationfunction can performed on social networks, the trivial function of providing relevant search results has become a differentiator for different social networks. This work takes into account the fact that all social networks are not similar and, hence, the same search result algorithm is not likely to be useful for all of them. As a result, an adaptive algorithm has been proposed which uses intuitive concepts like proximity, similarity and interaction to rank search results according to their relevance in a particular social network setting.

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1.ض M4 4 4 2 T f . 2 2 6 5 0 T D .

2.5M.5 4 6 c [(S o c) - 8 . T J / T T 9 B a s e d f