

# Recommendation Method for Social Service in Ubiquitous Environment

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## 〈Abstract〉

Recent development of information technologies produces a lot of community services. Social Network Service is one of the community services on the world wide webs. In the Social Network Service, a user can register other users as friends and enjoy communication through a virtual message. Previous researches show a few social service methods using manually generated tagging. However, the manual social tagging is not widely used in many social network services. Moreover, they do not consider ubiquitous computing environment. We propose a recommendation method for social service using contexts in ubiquitous environment. Our method scores documents based on context tags and social network services. Our social scoring model is computed by both a tagging score of a document and a tagging score of a document that was tagged by a user's friends.

Key Words : Recommendation, Social Service, Ubiquitous, Social Tagging

## I. Introduction

As one of the most successful Web 2.0 applications, social services have undergone a significant growth in the past several years.

Social Network Services(SNS) are increasingly attracting the attention of academic and industry researchers. What makes SNS unique is that they have a relationship with friends[1]. People tend to trust the opinions of friends they know rather than the opinions of strangers[2].

The wealth of available sensor technologies creates

more possibilities for context-aware systems. The context-aware systems should provide the user with adaptive recommendations for potentially relevant information. A challenging research issue in social computing is therefore the recommendation method using context.

Context has rarely been incorporated into social recommendation systems so far. But physical context and social context can be useful sources for improving recommendation[3].

Tag is a new form to index web resources, which help users to categorize and share the resources, and later search them. Also, the tags assigned by specified user reveal the user's interests, therefore, according to the tags user has already tagged, someone can find

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other users who have the similar interests, as well as similar interesting resources[4].

Tagging has rapidly become a popular way to annotate the content on social network sites. With the advancement of Web 2.0 and social network service, the recommendation is becoming increasingly important.

This paper proposes a new recommendation method for social service using contexts in ubiquitous environment. The main idea of the proposed system is scoring documents based on context tags and social network services. Our scoring model is computed by both a tagging score of a document and a tagging score of a document that was tagged by a user's friends.

In our method, users can work services using social tags without tagging manually in social network services. And our method uses contexts on ubiquitous environment.

The remainder of this paper is organized as follows. In Section 2, we give an overview of related works and background. Section 3 presents recommendation method for social service. Finally, we draw conclusions and discuss future work in Section 4.

## II. Background and Related Works

Our work is related to three research areas: social network service, tag recommendation and social recommendation. Here we briefly review these related works.

### 2.1 SNS(Social Network Service)

The evolution of the Web from Web 1.0 to Web 2.0

has brought up new platforms as SNSs that are used by users to articulate and manage their relationships.

SNS is defined as web-based service that allow individuals to (1) construct a public or semi-public profile within a bounded system, (2) articulate a list of other users with whom they share a connection, and (3) view and traverse their list of connections and those made by others within the system[1].

Relationships information obtained from a person's social network contacts can therefore be considered as one type of a person's social context, which extant literature refers to as 'who you are with' or one's 'social situation'[5], 'identity'[6], and 'social relations'[7] or even 'who you are similar to'. Thus, information about relationships from social network can be considered as one type of a person's social context.

Examples of popular SNS include: Facebook(<http://www.facebook.com>) is a social networking Web site that allows people to communicate with their friends and exchange information. In May 2007, Facebook launched the Facebook Platform which provides a framework for developers to create applications that interact with core Facebook features.

MySpace(<http://www.myspace.com/>) is a social networking Web site offering an interactive, user-submitted network of friends, personal profiles, blogs and groups, commonly used for sharing photos, music and videos.

Ning(<http://www.ning.com/>) is an online platform for creating social Web sites and social networks aimed at users who want to create networks around specific interests or have limited technical skills.

Twitter(<http://twitter.com/>) is an example of a micro-blogging service. Twitter can be used in a variety of ways including sharing brief information with users and providing support for one's peers.

## 2.2 Tag Recommendation

Tagging is a popular means of annotating objects on the web. Tags are an unstructured form of meta data where the vocabulary and reasoning behind each user's choice of tags varies. Common usage themes tend to emerge where people agree on the semantic description of online resources[8].

In these tagging services, the users can organize, share and retrieve online resources with tags easily. At the same time, the users of these tagging services have created large amounts of tagging data which have attracted much attention from the research community [9].

Most of the exiting tag recommendation systems are originated from collaborative filtering recommender systems(CF)[10,11], which are widely used in E-commerce [12]. In [13] and [14], CF is used in folksonomies for tag recommendations[13]. extends CF method so that a graph based recommender is applied in the folksonomy datasets. [14] describes some criteria for good tags and the categories of tags based on the attributes of themselves.

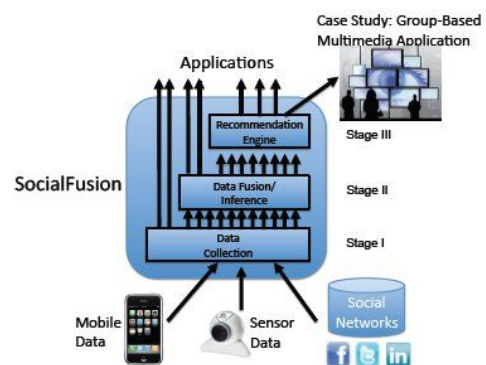
More works concern about the tag suggestion for weblogs. AutoTag[15] offers a small number of tags when given a weblog post. The system finds similar tagged posts and recommends some associated tags to a user for selection. Tagassist[16] uses some technology to enhance the performance of tag suggestion, and gives five different scoring parameters for tag evaluation. [17] proposes an approach to recommend tag automatically for weblogs. This solution makes use of a simple Vector Space Model (VSM) to find similar documents, and extracts the potential tags with extra information for user to select. [18] analyzes the

effectiveness of tags for classifying blog entries and finds that tags are useful for grouping articles into broad categories.

## 2.3 Social Recommendation

Social recommender systems utilize data regarding users' social relationships in filtering relevant information to users, and predict the utility of items, users, or groups based on the multi-dimensional social environment of a given user. Based on this model, it introduces recommendation mechanisms for content sharing frameworks[19]. This method take into account a specialized model of dependencies between users, items, and annotations that provides a good fit for observed properties of the folksonomy. Beyond these basic structures, modern Web 2.0 folksonomys contain additional features reflecting the social nature of the content sharing framework such as contacts, personal favorites, comments, groups, etc.

SocialFusion[20] is a framework to support context-aware inference and recommendation by fusing together mobile, sensor, and social data.



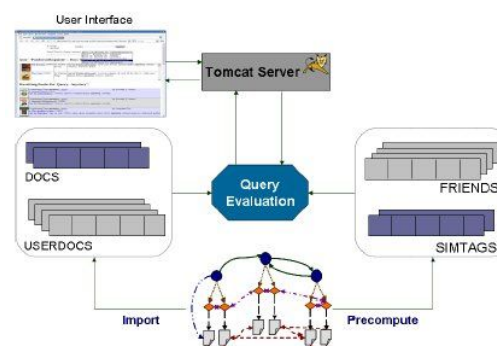
<Fig 1.> Framework of Social Fusion

Figure 1 illustrates SocialFusion's multi-stage computing framework. The first stage collects together data from three major classes of data input streams, namely social networks, mobile phones, and sensor networks. The second stage incorporates inference functionality whose task is to fuse the data and thus derive higher-level contextual meaning in the form of descriptors from the raw data. These descriptors, combined with the original data, are then supplied to a third stage consisting of a recommendation engine that decides what kind of context-aware action to take. SocialFusion supports real-time mobile social networking applications.

SENSE (Socially ENhanced Search and Exploration) [21,22] is a comprehensive framework for socially enhanced search, ranking, and recommendation. The SENSE system supports hybrid personalization along two dimensions: in the social dimension, a search process is focused towards items tagged by users explicitly selected as friends by the querying user, whereas in the spiritual dimension, users that share preferences with the querying user are preferred. Orthogonal to this, the system additionally integrates semantic expansion of query tags to improve search results.

It provides an efficient top-k algorithm that dynamically expands the search to related users and tags. It is based on principles of threshold algorithms, folding related users and tags into the search space in an incremental on-demand manner, thus visiting only a small fraction of the social network when evaluating a query. The core of SENSE scoring is formed by three different quantizations for friendship strengths, corresponding to the three different searches in communities.

Figure 2 shows an overview of the architecture of SENSE [21,22]. Data from social communities are imported and pre-computed into database-backed data structures used for query evaluation. Given a query which was entered by a user through a Tomcat servlet, the top-k-aware query processor uses this information to compute the best results for a query, which are again returned through Tomcat.



<Fig 2.> Architecture of SENSE

SENSE uses precomputed index lists and maintains the following lists: For each tag  $t$ , it maintains a list  $DOCS(t)$ , containing documents  $d$  tagged by at least one user and corresponding global tag frequencies  $TF(d, t)$ , ordered by descending  $TF(d, t)$ . For each user  $u$  and each tag  $t$  she used, it maintains a list  $USERDOCS(u, t)$  with the unsorted set of documents  $d$  tagged with  $t$  by  $u$ .

Precomputed friendships strengths between users are stored in  $FRIENDS SP(u)$  and  $FRIENDS SO(u)$  for spiritual and social friendships, respectively, which contain, for a user  $u$ , all related users  $u'$  and their similarity in descending order. Finally,  $SIMTAGS(t)$  contains for a tag  $t$  all similar tags  $t'$  with their similarity in descending order. These lists are

precomputed and updated regularly. There may be different instances of these lists, corresponding to different implementations of the strengths and similarities.

Recent social recommendation method recommends friends using physical and social context[27]. This research present the friendship score,  $FS(u, y)$  strength between user  $u$  and  $u$ 's friend  $y$  using physical and social contexts. The method presents a friendship score combining both spiritual friendship and social friendship. The spiritual friendship is computed by physical contexts and social friendship is computed by social contexts. The spiritual friendship score is computed by a logged context score and an inputted context score. However, this method only recommends friends, not documents.

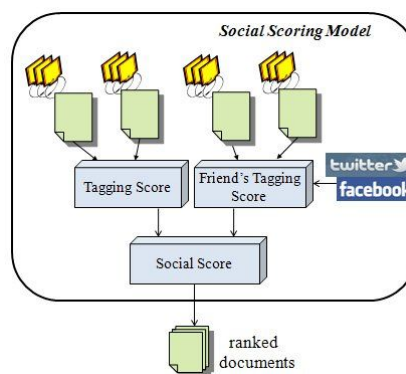
### III. Recommendation Method for Social Service

In this section, we present a recommendation method for social service in ubiquitous environment. Previous social recommendation method considers only social relationship of a given user. However, our social recommendation method recommends information suitable for user's current context using both context tags and social network.

Recent advanced researches present social service methods using manually generated social tagging [23]. But, the manual social tagging is not widely used in many social network services. The manual tagging makes it difficult to apply the previous methods in social services.

We propose a new recommendation method for

social service using contexts in ubiquitous environment. Context-aware computing is one of the most important technologies in ubiquitous computing. Context-aware computing makes the user interaction implicit. Our method shows some considerable advantages. Firstly, our method uses contexts in ubiquitous environment, as compared to previous social service recommendation method. Secondly, users can work services using context as tags without tagging manually in social network services.



<Fig 3.> Our Social Scoring Model

This paper describes a social scoring model. Figure 3 shows the model. It computes scores of documents from tagged document. For social recommendation, the model computes friend's tagging score of documents from social network services such as Twitter and Facebook. And then, our model combines the tagging score and friend's tagging score. Our social scoring model scores documents based on tags using contexts and social network services for each document.

Equation 1 shows our social score,  $SocialScore(T, d, u)$ . The  $SocialScore(T, d, u)$  is a score of a document  $d$  with respect to tag set  $T$  considering user  $u$ 's friends in social network. In equation (1),  $T$  is a tag set,  $d$  is a

document and  $u$  is a user. The social score is composed of a  $TaggingScore(T, d)$  and a  $FriendTaggingScore(T, d, u)$ , where  $T$  is a tag set,  $d$  is a document, and  $u$  is an user. We combine a tagging score of a document and a tagging score of a document that was tagged by a user's friends. They are combined by linear combination because of simplicity.

$$SocialScore(T, d, u) = \alpha \times TaggingScore(T, d) + (1 - \alpha) \times FriendTaggingScore(T, d, u) \quad (1)$$

The parameter  $\alpha(0 \leq \alpha \leq 1)$ , can be adjusted by users and application characteristics. If the value of parameter  $\alpha$  is decreased, the friend's tagging score is considered as more important than the other.

The  $TaggingScore(T, d)$  is a tag score of a document  $d$  that was tagged with a tag set  $T$ . In this paper, we apply the context preferences as the tags for each document. More precisely, we adopt the context tags by Kwon [24] for information retrieval on context-aware Web 2.0 environment. The context preference for each document can be extracted from the logs. Log analysis has widely applied in a broad range of research topics such as Web personalization and recommender systems [25,26]. Web server logs are the important resources for analyzing preferences for each document. From the result of analyzing the logs, we tag the context tags in documents [26].

The score  $TaggingScore(T, d)$  is computed by Equation (2). The  $TS(t_i, d)$  is the tag score of a document  $d$  that was tagged with a tag  $t_i$ . For  $TS(t_i, d)$ , we apply well known tf-idf scheme in information retrieval.

$$TaggingScore(T, d) = \sum_{t_i \in T} TS(t_i, d) \quad (2)$$

The  $FriendTaggingScore(T, d, u)$  is a score of a document  $d$  that was tagged with tag set  $T$  by a user  $u$ 's friends considering their popularity and friendship. The score  $FriendTaggingScore(T, d, u)$  is defined by Equation (3).

$$FriendTaggingScore(T, d, u) = \sum_{t_i \in T} \sum_{y \in friends(u)} (FPFS(u, y) \times FTS(t_i, d, y)) \quad (3)$$

The score is computed by a friend's tag score,  $FTS(t_i, d, y)$  and a friend score,  $FPFS(u, y)$ . The  $FTS(t_i, d, y)$  is the tag score of a document  $d$  with tag  $t_i$  by user  $u$ 's friend,  $y$ .

Moreover, we consider a friend score,  $FPFS(u, y)$  for each friend. In the friend score, it is considered both the friend's popularity and the friendship strength. For friend's popularity, it is used the UserRank method in previous research [23]. For the friendship strength, we adopt a friendship score,  $FS(u, y)$  by Kwon [27].  $FS(u, y)$  is the friendship score using physical and social contexts [27].

$$FPFS(u, y) = \beta \times UserRank(y) + (1 - \beta) \times FS(u, y) \quad (4)$$

Equation 4 shows out our friend score,  $FPFS(u, y)$  considering a friend's popularity and a friendship strength between a user  $u$  and his/her friend  $y$ . The result of the friend's popularity and the friendship score is composited using single adjustable parameter  $\beta$  ( $0 \leq \beta \leq 1$ ).

## IV. Conclusion

The Web 2.0 and SNS have revolutionized the way information is designed and accessed. Social service using crowd tagging is one of the most promising researches. However, previous works do not consider ubiquitous environment. Also, manual social tagging is not widely used in social network services.

We propose a recommendation method for social service in ubiquitous environment. Our method scores documents based on context tags and social network services. Our scoring model is computed by both a tagging score of a document and a tagging score of a document that was tagged by a user's friends.

This paper describes a social scoring model. The model is computed by a tag score of a document considering friend's popularity and friendship.

In future work, we will implement the algorithm using context tags and social network services. Moreover, we will make a prototype using our method.

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