Abstract

Existing social networking services recommend friends to users based on their social graphs, which may not be the most appropriate to reflect a user’s preferences on friend selection in real life. In this paper, we present a novel semantic-based friend recommendation system for social networks, which recommends friends to users based on their life styles instead of social graphs. By taking advantage of sensor-rich smartphones, Friendbook discovers life styles of users from user-centric sensor data, measures the similarity of life styles between users, and recommends friends to users if their life styles have high similarity. Inspired by text mining, we model a user’s daily life as life documents, from which his/her life styles are extracted by using the Latent Dirichlet Allocation algorithm. We further propose a similarity metric to measure the similarity of life styles between users, and calculate user’s impact in terms of life styles with a friend-matching graph. Upon receiving a request, Friendbook returns a list of people with highest recommendation scores to the query user. Finally, Friendbook integrates a feedback mechanism to further improve the recommendation accuracy. We have implemented Friendbook on the Android-based smartphones, and evaluated its performance on both small-scale experiments and large-scale simulations. The results show that the recommendations accurately reflect the preferences of users in choosing friends.
1. Introduction

Twenty years ago, people typically made friends with others who live or work close to themselves, such as neighbours or colleagues. We call friends made through this traditional fashion as G-friends, which stands for geographical location-based friends because they are influenced by the geographical distances between each other. With the rapid advances in social networks, services such as Facebook, Twitter and Google+ have provided us revolutionary ways of making friends. According to Facebook statistics, a user has an average of 130 friends, perhaps larger than any other time in history. One challenge with existing social networking services is how to recommend a good friend to a user. Most of them rely on pre-existing user relationships to pick friend candidates. For example, Facebook relies on a social link analysis among those who already share common friends and recommends symmetrical users as potential friends. Unfortunately, this approach may not be the most appropriate based on recent sociology findings. According to these studies or life style; 2) attitudes; 3) tastes; 4) moral standards; 5) economic level; and 6) people they already know. Apparently, rule #3 and rule #6 are the mainstream factors considered by existing recommendation systems. Rule #1, although probably the most intuitive, is not widely used because users' life styles are difficult, if not impossible, to capture through web actions. Rather, life styles are usually closely correlated with daily routines and activities. Therefore, if we could gather information on users' daily routines and activities, we can exploit rule #1 and recommend friends to people based on their similar life styles. This recommendation mechanism can be deployed as a standalone app on smartphones or as an add-on to existing social network frameworks. In both cases, Friendbook can help mobile phone users find friends either among strangers or within a certain group as long as they share similar life styles.

In our everyday lives, we may have hundreds of activities, which form meaningful sequences that shape our lives. In this paper, we use the word activity to specifically refer to the actions taken in the order of seconds, such as "sitting", "walking", or "typing", while we use the phrase life style to refer to higher-level abstractions of daily lives, such as "office work" or "shopping". For instance, the "shopping" life style mostly consists of the "walking" activity, but may also contain the "standing" or the "sitting" activities.

In spite of the powerful sensing capabilities of smart-phones, there are still multiple challenges for extracting users' life styles and recommending potential friends based on their similarities. First, how to automatically and accurately discover life styles from noisy and heterogeneous sensor data? Second, how to measure the similarity of users in terms of life styles? Third, who should be recommended to the user among all the friend candidates? To address these challenges, in this paper, we present Friendbook, a semantic-based friend recommendation system based on sensor-rich smartphones. The contributions of this work are summarized as follows:

• To the best of our knowledge, Friendbook is the first friend recommendation system exploiting a user's life style information discovered from smartphone sensors.
• Inspired by achievements in the field of text mining, we model the daily lives of users as life documents and use the probabilistic topic model to extract life style information of users.
• We propose a unique similarity metric to characterize the similarity of users in terms of life styles and then construct a friend-matching graph to recommend friends to users based on their life styles.
2. Development Process
Before developing the tool it is necessary to determine the time factor, economy and company strength. Once these things are satisfied, then next step is to determine which operating system and language can be used for developing the tool. Once the programmer start to building the tool the programmer need lot of external supports. This support can be obtained from the senior programmers, from books and from websites. Before building the system the above consideration are taken into account for developing the proposed system.

Semantic-based friend recommendation system for social networks, which recommends friends to users based on their life styles instead of social graphs. By taking advantage of sensor-rich smartphones, Friendbook discovers life styles of users from user-centric sensor data, measures the similarity of life styles between users, and recommends friends to users if their life styles have high similarity. By taking advantage of sensor-rich smartphones, Friendbook discovers life styles of users from user-centric sensor data, measures the similarity of life styles between users, and recommends friends to users if their life styles have high similarity.

3. Existing System
Existing social networking services recommend friends to users based on their social graphs, which may not be the most appropriate to reflect a user’s preferences on friend selection in real life.

4. Proposed System
A novel semantic-based friend recommendation system for social networks, which recommends friends to users based on their life styles instead of social graphs. By taking advantage of sensor-rich smartphones, Friendbook discovers life styles of users from user-centric sensor data, measures the similarity of life styles between users, and recommends friends to users if their life styles have high similarity. We model a user’s daily life as life documents, from which his/her life styles are extracted by using the Latent Dirichlet Allocation algorithm. Similarity metric to measure the similarity of life styles between users, and calculate users’ Impact in terms of life styles with a friend-matching graph. We integrate a linear feedback mechanism that exploits the user’s feedback to improve recommendation accuracy.

5. Module Description
A. Life Style Modeling
Life styles and activities are reflection of daily lives at two different level where daily live can be treated as mixture of life styles and life style as a mixture of activities. By taking the advantage of recent developments in the field of text mining, they model the daily lives of user as life documents, the life styles as topics, and the activities as words.

B. Activity Recognition
In activity recognition there are two motion sensors, accelerometer and gyroscope, are used to infer users’ motion activities. Generally there are two mainstream approaches: Supervised learning and unsupervised learning. They use unsupervised learning approaches to recognize activities. Here, they adopt the popular K-means clustering algorithm to group data into clusters, where each cluster represents an activity.
C. **Life Style Extraction using LDA**

   It is also worth noting that since our system uses unsupervised learning algorithms to recognize activities and the topic model to discover life styles, the physical meanings of derived “activities” (or cluster centers from the K-means algorithm) or “topics” are unknown to us. As mentioned in, such meaning can be estimated via the additional step of comparing the topic activations to the actual structure of the subject’s day and then identifying topics that correspond to possible daily routines. In Friendbook, since they are to only compare “similarity” in activities or topic patterns, there is no need to infer the physical meaning of each cluster center or topic. On the other hand, not revealing the actual physical meaning of activities and topics also has advantages from the perspective of preserving privacy.

D. **Similarity Metric Module**

   They define a new similarity metric to measure the similarity between two life style vectors. They argue that the similarity is not only affected by their life style vectors as a whole, but also by the most important life styles, i.e., the elements within the vector with larger probability values, also known as the dominant life styles. We also argue that two users do not share much similarity if majority of their life styles are totally different.

E. **Friend Matching Graph and User Impact**

   Friend-matching graph is used to represent the similarity between their life styles and how they influence other people in the graph. In particular, they use the link weight between two users to represent the similarity of their life styles. Based on the friend-matching graph, they can obtain a user’s affinity reflecting how likely this user will be chosen as another user’s friend in the network.

F. **User Impact Ranking**

   Impact ranking means a user’s capability to establish friendships in the network. PageRank which is used in web page ranking, they form the idea that a user’s ranking is reflected by his neighbors in the friend-matching graph and how much his neighbors endorse the user as a friend.
Algorithm 1 Computing users’ impact ranking

Input: The friend-matching graph $G$.
Output: Impact ranking vector $r$ for all users.
1: for $i = 1$ to $n$ do
2: $r_0(i) = \frac{1}{n}$
3: end for
4: $\delta = \infty$
5: $\epsilon = e^{-\alpha}$
6: while $\delta > \epsilon$ do
7: for $i = 1$ to $n$ do
8: $r_{k+1}(i) = \sum_{j=1}^{n} \frac{1 - \beta}{n} r_k(j) + \frac{\varphi}{n} \sum_{j} w(i,j) r_k(j)$
9: end for
10: $\delta = \sum_{i=1}^{n} |r_{k+1}(i) - r_k(i)|$
11: end while
12: return $r$

G. Friend Recommendation

It receives user's request and server would extract the user’s life style vector and based on which recommend friend to the user. Recommendation results are highly dependent on user’s preference. The recommendation results are highly dependent on users' preference. Some users may prefer the system to recommend users with high impact, while some users may want to know users with the most similar life styles. It is also possible that some users want the system to recommend users who have high impact and also similar life styles to them.

![Figure 5.2: Friend book Architecture](image-url)
6. Application & Advantages of Proposed System

To measure similarity among users, it requires a life document which contains user’s daily activity, by the recent advances in smartphones, which have become more and more poplar in people’s lives. These smartphones (e.g., iPhone or Android-based smartphones) are equipped with a rich set of embedded sensors, such as GPS, accelerometer, microphone, gyroscope, and camera. Thus, a smartphone is no longer simply a communication device, but also a powerful and environmental reality sensing platform from which we can extract rich context and content-aware information. From this perspective, smartphones serve as the ideal platform for sensing daily routines from which people’s lifestyles could be discovered.

- Recommended potential friends to users if they share similar life styles.
- The feedback mechanism allows us to measure the satisfaction of users, by providing a user interface that allows the user to rate the friend list.

7. Conclusion

In this paper, we presented the design and implementation of Friendbook, a semantic based friend recommendation system for social networks. Different from the friend recommendation mechanisms relying on social graphs in existing social networking services, Friendbook extracted life styles from user-centric data collected from sensors on the smartphone and recommended potential friends to users if they share similar life styles. We implemented Friendbook on the Android-based smartphones, and evaluated its performance on both small-scale experiments and large-scale simulations. The results showed that the recommendations accurately reflect the preferences of users in choosing friends.

References