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# Exploiting User Check-In Data for Geo-Friend Recommendations in Location-Based Social Networks

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## ABSTRACT

The development of Web 2.0 technologies has meant that online social networks can both help the public facilitate sharing and communication and help them make new friends through their cyberspace social circles. Generating more accurate and geographically related results to help users find more friends in real life is gradually becoming a research hotspot. Recommending geographically related friends and alleviating check-in data sparsity problems in location-based social networks allows those to divide a day into different time slots and automatically collect user check-in data at each time slot over a certain period. Second, some important location points or regions are extracted from raw check-in trajectories, temporal periodic trajectories are constructed, and a geo-friend recommendation framework is proposed that can help users find geographically related friends. Finally, empirical studies from a real-world dataset demonstrate that this paper's method outperforms other existing methods for geo-friend recommendations in location-based social networks.

## KEYWORDS

Friend Recommendations, Location-Based Services, Point of Interest, Social Networks

## 1. INTRODUCTION

Rapid advances in technology have led to a situation in which a growing number of mobile devices such as laptops, PDAs and smartphones come equipped with GPS capabilities; this makes check-ins a new lifestyle choice for countless users who share their positions, tips, and experiences along with points-of-interest (POIs) with friends via location-based social networks. This paper explores the problems of building a geo-friend recommendation system for location-based social networks. The availability of location and trajectory information can improve the performance of the recommendation system and close the gap between online social services and users' real lives.

A new and crucial dimension is conceived with the help of location-based social networks in recording user social movements and understanding their mobility; in addition, it breaks down the walls between reality and virtual social life. One major difference between virtual social

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networks and location-based social networks is that the latter is much closer to real life (Morstatter et al., 2015). Thus, new friends can be recommended in location-based social networks through geographical characteristics.

Successfully finding geo-friends has potential applications in many areas, for instance, their probability of being able to engage in local offline events (such as holiday parties, football games, or book clubs) is presumably higher than friends from virtual online social networks. For example, Steven is looking for some new geo-friends to participate in a local charity activity with him. Three candidates are provided: James who has many friends in common with Steven, but stays in a foreign country; Andy who works for the same company as Steven but shares no similarities with regard to social network structure; and Edward who shares a few mutual friends and pays a visit to the same gymnasium and same comic book store as Steven every week. Obviously, Edward should be recommended as Steven's geo-friend, since he is considered to have a higher geographical similarity in real life and is more likely to be inclined to join in the local activity with him.

New friends in the reality who prone to be geographically related and geographically similar usually hide in ones' mobile trajectories (Yu et al., 2011). Geo-friends recommendation can be an assistive tools in location-based social networks (like MOMO in China), which can help user to find more friends who share similar taste/interest in the real world. However, the key issue of this application is how to abstract users' interest in the real world, fortunately, some research results (Morstatter et al., 2015) show that users' check-ins in location-based social networks can reveal their interest in the real world. Therefore, we would like to use users' check-ins to design a geo-friends recommendation framework, our main contribution of this paper is as follows:

Unlike vehicle trajectories in vehicular networks, the check-in actions of users in location-based social networks are a voluntary choice, which results in a serious sparsity in the raw check-in trajectory. This problem can be solved by first dividing days into different time slots and automatically collecting users' checked-in data at each time slot over a certain period, then we extract some important interesting points or regions from the raw trajectories that may be Points of Interest or Times of Interest, and define three patterns with which to illustrate people's real-life social interactions and correlations hiding in check-in trajectories. Finally, we propose a novel spatio-temporal trajectory similarity calculation method based on the three patterns and a geo-friends recommendation algorithm, a series of experiments conducted on real-world datasets demonstrate its accuracy and feasibility.

## 2. RELATED WORK

### 2.1. Friend Recommendation in Location-Based Social Networks

Many recent researches have been carried out on friend recommendation in location-based social networks (Yu et al., 2011; Sui et al., 2015; Qiao et al., 2014; Lu et al., 2016; Scellato et al., 2011). Link prediction or link analysis is one of the most important techniques adopted in friend recommendation system for location-based social networks, which help user to discover more potential friends and expand social relation network as well in terms of linkage. The key point of this method is how to determine a connection weight score between node pairs by all possible means. For example, Yu et al. (2011) aim to detect friends in the social structure that are related to geographical location, they build a pattern-based heterogeneous information network by combining GPS information and social network structures, furthermore, different calculation methods are adopted to define the weights of different nodes in the heterogeneous information network and random walk process is employed to estimate link correlation and help users find their compatible geo-friends. Scellato et al. (2011) find that approximately 30 percent of new links are added among geo-friends in location-based social networks, moreover, this prediction scope can be reduced 15-fold, while 66 percent of future connections can still be found. Therefore, a learning framework is proposed, which makes use of new prediction features based on users' access location to predict new connections among friends-of-friends and geo-friends.