Location Based Friend Recommendation System

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***Abstract*: Friend recommendation is one of the most popular characteristics of social network platforms, which recommends familiar people to users. The concept of friend recommendation originates from social networks such as Twitter & facebook, which uses friends-of-friend method to recommend people. We can say users do not make friends from random people but end up making friends with their friends' friends. The existing methods have narrow scope of recommendation and are less efficient. We put forward a new friend recommendation model to overpower the defects of existing system. For better friend recommendation system with high accuracy, we will use collaborative filtering method to compare similar, dissimilar data of users and will make a recommendation system which gives user to user recommendation based on their similar choices, activities and preferences. Location based friend recommendation system are becoming popular because it brings physical world to digital platform and gives better insight of user's preferences or interest This recommendation system will increase the scope of recommendation from one user to other with similar set of interest and their location.**

Index Terms: **Friend recommendation, collaborative filtering, social network, Recommendation system**

I. Introduction

Friend recommendation service in LSBN platform recommends familiar or interested user to each other. About 71% of internet users were online social network users and they will grow in near future. Social networking is very popular online activities with high rate of user interactions & expanding mobile possibilities. The growth rate in use of smart phones and mobile devices is very rapid and has opened up new areas of mobile social networks with increased features. With over billions of monthly active users on social network. Facebook is currently the market leader in terms of user engagement reach and scope [1]. Recent advancement in technology has improved social networking services, allowing users to share their locations and location-related contents. Such type of social networks are referred as location-based social networks (LBSNs). The objective of our proposed recommendation systems is to include user profiles, interest, and user location histories and apply collaborative filtering methods for user to user recommendation to increases scope of recommendation and make it more efficient.

I.1 Recommender Systems: A Recommender system predicts preference a user would give to something by filtering & analysing information of users. Recommender systems provide recommendations of all types ranging from books to movies to music and users. Many social media sites like facebook, twitter, foursquare and instagram are also recommender sites which provide recommendations for friends and followers. NetFlix.com is very famous online platform for watching and it uses movie recommender also.

I.2 Collaborative Filtering: Collaborative filtering is a technique to collect and analyze a large amount of information about user's activities or preferences and predicting what users will prefer based on their similarity to other users. The intension behind Collaborative filtering is that people who agreed in the past will agree in the future, and that they will like similar kinds of items as they liked in the past. The CF method used in LBSNs consists of 3 steps: 1) candidate selection, 2) similarity inference, and 3) recommendation score predication [4]. The recommender system compares the data of different users and calculates a list of recommended items or user. One sample of this method is item-to-item collaborative filtering those people who buy x they will also like to buy y Facebook, MySpace, LinkedIn, and other social networks use collaborative filtering to recommend new friends and groups by examining the network of connections between a user and their friends.

I.3 Pearson Correlation Coefficient: The Pearson correlation coefficient measures the strength between variables and relationships. It is very helpful statistical formula is often referred to as the 'Pearson R' test. Whenever we want to find how strong relationship is between two variables, it is a good idea to apply a Pearson correlation coefficient test. The value of pearsons correlation coefficient ranges from -1 to +1.

$$r = \frac{N\Sigma xy - (\Sigma x)(\Sigma y)}{\sqrt{[N\Sigma x^2 - (\Sigma x)^2][N\Sigma y^2 - (\Sigma y)^2]}}$$

Where:

N	=	number of pairs of scores
Σxy	=	sum of the products of paired scores
Σx	=	sum of x scores
Σy	=	sum of y scores
Σx^2	=	sum of squared x scores
Σy^2	=	sum of squared y scores

Pearson Correlation Coefficient Formula

II. LITERATURE SURVEY:

Temporal, spatial & social correlation are 3 main attributes of any LBSN. However, the situation which include these 3 features cannot be solved in previous algorithms. There is no method which utilizes all information properly. A new approach of friend recommendation is proposed, which aims to recommend friends with similar location preference for LBSN's users. This approach first, use the method of local random walk based on Markov chain to calculate the user's friendship similarity on social network. then, it calculate the user's location preference similarity in the real world by check-in data and finally recommend friends to users by building a mixed user preferences model [2].

A new friend recommendation model (FE-ELM), is proposed where friend recommendation is regarded as a binary classification problem. In this model first feature extraction is done by using different strategies and then in training process ELM classifier is used to learn the the spatial-temporal, social and textual feature , finally experiments are performed on real datasets for better efficiency and accuracy [3].

Authors after evaluating and comparing of 5 types of recommender system: a people-based, a tags-based, 2 types of a hybrid recommender : i) PTBR a combination of people or tags (or-PTBR), ii) and-PTBR, suggesting only items related to both people and last one is tag and a popularity-based recommender found that joining both related tags and people in the user profile lowers the percentage of already known items, increases the diversity of item types and increase the interest in recommended items over a pure tag-based approach but it also [4].

Location brings new property as well as challenges to recommender systems for LBSNs. This new challenges are discussed in this paper. Author has categorized the recommender systems in 3 ways by the objective of recommendation, by the methodologies used, by the data sources used which include locations, users and activities, content-based, link analysis-based, and collaborative filtering and data sources: user profiles, user online histories, and user location histories respectively. For each category, the contributions & aims of each system are summarized. It introduces the concepts, unique properties, challenges, evaluation methods and future work for recommender systems in LBSNs [5].

In this paper, Hierarchical-graph-based similarity measurement framework is proposed, which uses location histories and find the similarity between users. In this framework, 3 factors sequence property of users' movements, Hierarchy property of geographic spaces, Popularity of different locations are considered. Using HGSM to estimate the similarity between users, a collaborative filtering based method is also employed in our system to find an individual's interest in unvisited geospatial regions [6].

A friend recommendation algorithm is proposed which is known as Random walk based context-aware friend recommendation algorithm. This algorithm uses an undirected un-weighted graph that shows users, locations & their relationships. According to the current context of the user it constructs a sub-graph. Local experts and popular locations in region are added to this sub-graph. After constructing the sub-graph, this sub-graph is given as input to our random walk algorithm, and it calculates the recommendation probabilities of users for friend recommendation. A list of potential friends is provided to user according to output of the random walk algorithm [7].

Recommendation system make use of user profile, item description and past behaviour for recommendation but no attention has been given to personalization based explicitly on social networks. Author has used information from the last.fm social network such as social graph among users, tracks & tags, effectively including bonds of friendship. We have done series of experiments between the Random Walk with Restarts model and a user-based collaborative filtering method. The results prove that the graph model gains from the additional information implanted in social knowledge [8].

The paper focuses on hurdles in the collaborative filtering & gives better outcomes. To solve cold start problem for the new user, we could replenish user's profile in different ways, the general approach is to require user provide their profile while login the social account and for the new item, we could mixed the collaborative & content-based recommender algorithm. There are some solutions for the sparsity problem. One uses filling or decreasing the dimension to decrease the sparsity of the matrix. Another solution improves the efficiency of the algorithms without alteringing the sparsity of the matrix [9].

Author through analysis on a dataset collected from Foursquare, observe that there exists strong social and geo-spatial bond among users and their preferred locations. So, a friend-based collaborative filtering approach is developed for location recommendation based on ratings of places. Additionally, Geo-Measured-FCF based on heuristics derived from observed geospatial features in the Foursquare dataset. Evaluation is done to validate proposal and make comparison between the collaborative filtering (CF), social collaborative filtering (SCF) and random walk and restart (RWR) [10].

LBSN is a new social networking platform for making friends, sharing information, searching contents with the location enabled data but it has increased concern for privacy protection, friend recommendation etc. In this paper SVM based approach for friendship prediction on LBSN is proposed. In this model user social relations, check-in distance and check-in type are extracted, information gain is calculated and prediction model is established [11].

III. PROBLEM STATEMENT: The existing system of recommendation used by social media websites are inefficient as they make use of content based filtering and even if they use collaborative approach the scope is limited because they are based on friend of friend's concept. Many users do not find recommendation made by existing system helpful as they do not know a person or they might not have similar interest, it leads to less interaction over social network among different users which is not beneficial for social network websites as user do not spend much time on site. If users don't find new people and spend less time on social network platform then it is a sign of worry for them therefore we need to recommend new people to users for similar interest.

III.1 Research Gaps:

- A location shared by 2 user could be evidence of similarity or it could also indicate location is popular so more attributes need to taken into account before generating recommendation to find proper connection between users.
- Most LBSN recommendation system suggest locations to user but not friends with similar interest.
- If two users are same in social structure and has overlapped location history there is chance that can become friend.

IV. PROPOSED SYSTEM: The location-based social network gives user an opportunity to check-in their current location and share it with other users [7]. We propose a new friend recommendation algorithm on basis of collaborative approach. We will consider the current context i.e. location (fine and coarse), interest preference etc. of the user to predict personalized recommendations. First we will select a target user and then similarity calculation is done by comparing check in data. We will create a location Co-visitation matrix or Location preference vector. In our dataset acquired from facebook, we don't have any explicit preference ratings therefore we use the how many times a user has visited to a location as an implicit rating of location preference and we will also create interest preference vector and city preference vector where interest is indicated as '1' and '0' for like and dislike respectively . Now we calculate 3 similarity weights based on the users check_in history, interest preference and users visited cities etc respectively using the Pearson correlation coefficient

$$\text{Similarity}(U, V) = \text{Cos}(U, V) = \frac{\sum_{i=1}^{n} U\,V}{\sqrt{\sum_{i=1}^{n} U^2}\sqrt{\sum_{i=1}^{n} V^2}} \qquad (1)$$

and then use following equation for calculating final recommendation score.

$$\text{Recommendation\_score} = \frac{\text{Loc\_pref\_sim} + \text{Intrest\_Sim} + \text{City\_pref\_sim}}{3} \qquad (2)$$

IV.1 Proposed algorithm:

1. Select a target user U.
2. Count the each user's number of check-in in different locations and set the number as 0 if there is no check_in. Then the user's location preference vector is formed.
3. Similarly form preference vector for interest and visited cities.
4. Calculation of location preference similarity
$$\text{Loc\_pre\_sim}(U, V) = \frac{\sum_{i=1}^{n} U\,V}{\sqrt{\sum_{i=1}^{n} U^2}\sqrt{\sum_{i=1}^{n} V^2}}$$
5. Calculation of Interest preference similarity
$$\text{Intr\_pre\_sim}(U, V) = \frac{\sum_{i=1}^{n} U\,V}{\sqrt{\sum_{i=1}^{n} U^2}\sqrt{\sum_{i=1}^{n} V^2}}$$
6. Calculation if City preference similarity
$$\text{City\_pre\_sim}(U, V) = \frac{\sum_{i=1}^{n} U\,V}{\sqrt{\sum_{i=1}^{n} U^2}\sqrt{\sum_{i=1}^{n} V^2}}$$
7. $\text{Recommendation\_score} = \frac{\text{Loc\_pref\_sim} + \text{Intr\_pref\_sim} + \text{City\_pref\_sim}}{3}$
8. Generate list of top- n recommended friends.

V. RESULT DISCUSSIONS: Let we have selected a target user with user id 1. Now we will calculate cosine similarity for different features by using equation (1). The similarity score for location preference similarity, Interest preference similarity and City preference similarity between Target User and top 5 similar users is shown in table along with final recommendation score calculated by using equation (3).

User / Features	U2	U3	U4	U5	U6
Check_in	0.7894	0.6842	0.5263	0.6315	0.5263
Interest	0.4705	0.4705	0.2941	0.4117	0.4117
Visited City	0.5000	0.5000	0.7500	0.5000	0.5000
Rec_score	0.5866	0.5516	0.5234	0.5144	0.4793

We will recommend top-n similar users as friend to target user. To evaluate performance say users with location similarity above a threshold value θ should be potential friends. Value of θ should be specified correctly because if θ is too small, the accuracy of recommendation will be reduced on the other hand if θ is too big, the number of friends that can be recommended will be very less.

V.1 Evaluation standards: This paper takes Precision, Recall and F1_measure as the evaluation indexes of the experiment.
Precession: It is the ratio of correctly recommended friends to all friends which is recommended.
Recall: Recall is the ratio of correctly predicted friends to the all user expected to be friends.
F1_score: F1 Score is calculated by Precision and Recall values. This score takes both false positives & false negatives into consideration. F1 score is better and useful than accuracy.

$$F1\_Score = 2*(Recall * Precision) / (Recall + Precision)$$

V.2 Comparison with Other Models

Compared with the "Friend Recommendation Algorithm for Online Social Networks Based on Location Preference", proposed by Manfang Wu, Zhanquan Wang,,Haoran Sun,,HaiLong Hu, The below table 5.2 shows the exact calculated values for both the algorithms. We can see that our algorithm reaches better precision, recall and f1_measure value than the existing algorithm on our collected dataset. Also our calculation process is relatively easier to understand.

Algorithm	Proposed Method	Existing method
Precision	80	70
Recall	100	87.5
F1_measure	88.88	77.77

VI. CONCLUSION: We propose a new method for recommending friends on social media platforms based on users profile data, check in activities, interest etc. A recommender engine based on comparing check in activities, location or interest of one user with other with generates better recommendation results that are significantly more relevant to the user than the friend of friend's based system. The proposed system will increase the scope of recommendation. Now a days all social media websites has recommendation system. Recommendation system put forward by us is user-user recommendation system therefore it is applicable in social network platforms which support friends, follower concept.

REFERENCES

[1] https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users, July 2017

[2] Manfang Wu, Zhanquan Wang, Haoran Sun, HaiLong Hu Wangsu, Friend Recommendation Algorithm for Online Social Networks Based on Location Preference, Conference on Information Science and Control Engineering, © 2016 IEEE

[3] Zhen Zhang1 · Xiangguo Zhao1 · Guoren Wang1, FE-ELM: A New Friend Recommendation Model with Extreme Learning Machine Received: 26 September 2016 / Accepted: 30 May 2017 © Springer Science+Business Media New York 2017

[4] Ido Guy, Naama Zwerdling, Inbal Ronen, David Carmel, Erel Uziel, Social Media Recommendation based on People and Tags, *SIGIR'10*, July 19–23, 2010, Geneva, Switzerland.

[5] Jie Bao · Yu Zheng · DavidWilkie ·Mohamed Mokbel, Recommendations in location-based social networks: a survey © Springer Science+Business Media New York 2015

[6] YU ZHENG, LIZHU ZHANG and ZHENGXIN MA et. al, Recommending Friends and Locations Based on Individual Location History, ACM Transactions on the Web, Vol. 5, No. 1, Article 5, February 2011.

[7] Bagci H, Karagoz P, Context-aware friend recommendation for location based social networks using random walk, 25th international conference on world wide web, WWW 2016. Montreal, Canada, April 2016.

[8] Ioannis Konstas, Vassilios Stathopoulos, Joemon M Jose, On Social Networks and Collaborative Recommendation, *SIGIR* July 2009, Boston, Massachusetts, USA.

[9] YingtonG, Hao Yang et., A Survey of Collaborative Filtering Algorithms for Social Recommender Systems, 12th International Conference on Semantics, Knowledge and Grids © 2016 IEEE

[10] Mao Ye Peifeng Yin Wang-Chien Lee, Location Recommendation for Location-based Social Networks, ACM GIS '10 , November 2010. San Jose, CA, USA.

[11] Gao Xu-Rui1, Wang Li1, and Wu Wei-Li1, An Algorithm for Friendship Prediction on Location-Based Social Networks, © Springer International Publishing Switzerland 2015