A Location Based User Recommendation Method Based on Meaningless TrajectoryData Removal

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1. Introduction

Location based services have been increased with the development of mobile social network services. Location based recommendation services compute user preferences or moving patterns using user historical trajectories and then search and recommend similar users. A lot of studies have been in progress to recommend similar users correctly.

The existing location based recommendation methods use whole historical trajectories, in which there exist some locations where users do not want to visit. However, they did not reflect user preferences. Therefore, it is necessary to judge whether the visited locations are meaningless or not and generate new trajectories by removing meaningless locations from the original trajectories. The similar users can be searched and recommended by comparing the generated trajectories. The existing methods [1] [2] [3] [4] which consider various characteristics recommend users or locations by generating trajectory data that users prefer and comparing them. However, the existing methods cannot reflect user preferences since theyuseda user's whole visiting locations as the user trajectory.

In this paper, we propose a user recommendation method, in which the meaningless trajectories are removed. We judge meaningless locations and generate new trajectories by removing the meaningless locations. The proposed methodcalculates the frequency of the new generated trajectories and compares only high frequency trajectories. Compared with the existing methods, the proposed method reduces the computation costs and recommends more similar users.

2. The Proposed User Recommendation Method

A user preference is reflected at a trajectory. The existing methods cannot reflect. The proposed method, recommends more similar users by comparing the generated trajectory data

First, we grasp whether companions exist or not. If companions exist, we can say there is a high probability that the visited locations are a result of mutual consultation and not an individual decision of the user. By comparing the trajectory data of friends registered in SNS, the companions can be determined if users are in the same location at the same time. If a user has companions, the trajectory data of the user and companions are generated. If the trajectory of a user and his/her companions is overlapped with the trajectory of the user and the other companions, the overlapped part of the trajectory is used as the trajectory of the user.

Next, we define the criteria of a meaningless location and remove it from the original trajectory data. Visiting time is a very important factor to determine the meaningless locations..The existing methods do not consider the visiting time of a particular place where users visited from generated trajectory data. A location with short visiting time is removed from the trajectory data by using formula (1) because it is not meaningful for users to stay long.

$$\Delta t < \theta_{th} \qquad (1)$$

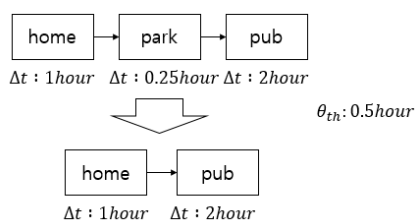

Figure 1. Removing a location with short visiting time

Periodically visited locations are meaningless for users. For instance, the same locations such as school and company that users visit everyday are meaningless for preference of users. The locations where users periodically visited every week are accumulated. The proposed method determines whether the locations where the user visited every week are meaningful or not by using formula (2).In general, periodically visited locations are set to low weight values. However, the periodically visiting locations in the weekend are determined to be meaningful because a user chooses them. In this case, we set a high weight for the location.

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$k = \sum_{n=1}^{N} \frac{N-n+1}{N}$ (2)
(N: Total weeks, n: the number of the visits of the same location)

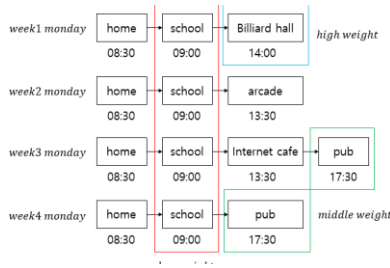

Figure 2. Setting a weight fora periodically visited location

Finally, we search similar usersand then recommend them.The proposed method computes the similarity between the trajectories by using formula 3, where m1 and m2 are the total lengths of trajectories of user1 and user2, respectively.

$$\text{similarity}(\text{tra1}, \text{tra2}) = \max\left\{\frac{2}{m_1+m_2}\right\} \times \sum_{i=1}^{m_1} \sum_{j=1}^{m_2} s(pp1_i, pp2_j) \quad (3)$$

$$s(pp1_i, pp2_j) = \begin{cases} 1, (if\ pp1_i = pp2_j) \\ 0, otherwise \end{cases}$$

Since the existing methods should process the whole trajectory data in formula 3, they require high computation costs.However, theproposed method compares only the trajectories that their frequencies are beyond a specifiedthresholdvalue. As a result, the proposed method reduces the number of comparisons between the trajectories and improve query processing by removing the low frequency trajectories.

3. Experimental Evaluation

In order to show the superiority of the proposed method, we evaluate the performance of the proposed method in the environment of [2]. The experiments includes 1,120 trajectories from 20 peoplein 8 weeks. Figure 3 shows the executiontime of the existing method and the proposed methodaccording to the number of users. As shown in Figure 2, the proposed method improves about 114% over the existing method in terms of execution time. Figure 4 shows the similarity scores between a sample user and other users. As shown in Figure 4, the proposed scheme and the existing scheme recommend user 6 as a user with the most similar patterns. However, the proposed scheme recommends user 14 as the second similar user, while the existing scheme recommends user 10. As a result, the proposed scheme is more correct than the existing method since the trajectories of the existing method contain meaningless locations.

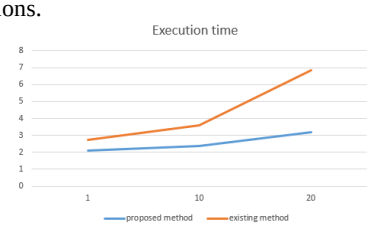

Figure 3. Execution time

Figure 4. Similarity score

4. Conclusion

In this paper, we proposedan efficient user recommendation method that improves performance by removing the meaningless trajectories based on user preferences. The proposed method undergoes a preprocessing step which removes meaningless trajectory data and generates new trajectories. Next, by using new trajectories, more similar users can be searched and recommended. It was shown through various experiments that the proposed method outperforms the existing method. In the near future, we will evaluate the performance of the proposed method in various environments.

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