Next Stop Recommender

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***Abstract*—User wandering behaviours may involve many location visits in different order. The research team has proposed an algorithm which can provide users recommendation for their next visit according to the similarity of their behaviours between each others and the connections amongst locations. In order to test the effectiveness of proposed algorithm the research team develops a mobile app – Next Stop Recommender – for Android platform. This paper focuses on the app itself and discusses the potential use of the app and the enhancement directions of the proposed algorithm.**

Keywords—mobile apps; recommender; data mining; casual wandering; route pattern

I. INTRODUCTION

People who travel to an unfamiliar destination usually plan ahead. They will survey on the places that they are interested and arrange their itineraries according to how much they like the places and how easy and complex to get there. However, not all information of the places at the destination is accessible to everyone. Some travelers may not be aware of particular places that they also like it beforehand. Some places may have no detailed enough information for travelers to identify the places are what they want to visit.

The research team thinks it would be better for travelers to have next stop recommendations while traveling from one place to another. The research team has designed an algorithm which is capable of making recommendations for a traveler by measuring the similarity of his or her sequential wandering behaviour from all others'. An Android mobile app, Next Stop Recommender, is developed for data collection and concept proof purpose.

This paper is organized as follows. Section 2 briefly explains the algorithm and flow proposed by the research team. Section 3 introduces the mobile app – Next Stop Recommender. Section 4 talks the data collected and processed behind the scene in visualized way. At the end, Section 5 discusses the limitations the proposed algorithm and the app have and enlightens the directions the research could be extended further in the future.

II. RECOMMENDATION BASED ON ROUTE PATTERNS

Two kinds of recommendations that a system can make for a traveler are content-based and collaborative recommendations [2]. Doesn't like content-based recommendations that a system recommend similar products and choices the user had in the past (e.g., Amazon's book recommendation system), collaborative recommendations are made by the systems trying to predict a user's preference towards the particular product or choice based on other users' decisions [3] (e.g., the Jester system [4] and PHOAKS system [6]).

Making recommendations for a traveler is more like collaborative recommendations because the system needs to identify the previous travelers that visit same places in same order with the traveler and then recommends the next places visited by those previous users to him or her. The difference between systems make next stop recommendations and collaborative recommendations is the system makes next stop recommendations needs to consider the order of choices made by the users. Shani, Brafman and Heckerman (2005) argue that the recommendation process is a sequential decision problem and use Markov decision processes to make recommendations [5]. Tseng and Lin (2006) use n-gram based sequential pattern mining techniques to align mobile user's web usage sequence with his or her location sequence [7].

The research team designs a novel next stop recommendation algorithm [1]. The algorithm uses the concept of sequential patterns to define a traveler's route patterns and uses sequential pattern mining methods to extract popular route patterns, which are then turned into a set of recommendation rules. Given a traveler's visit logs, the algorithm will first find out which rules are applicable to the traveler, sort the rules according to a ranking scheme, and finally present the top-n highest-ranking rules' results as the recommendations to the traveler. More details of the proposed algorithm can be found in [1].

For briefly explaining how the proposed algorithm works, a typical scenario of the Bar Tour is used as follows. As Fig. 1 shows, there are many pubs, clubs, cafés, and bar & grills in a city. Different travelers may have their preferences in paying a visit to these places as the routes in different colors shown in Fig. 1. Assuming Maz is bar touring in downtown Toronto. He

first visits J, then G, C and A, and now he wonders which one to go next.

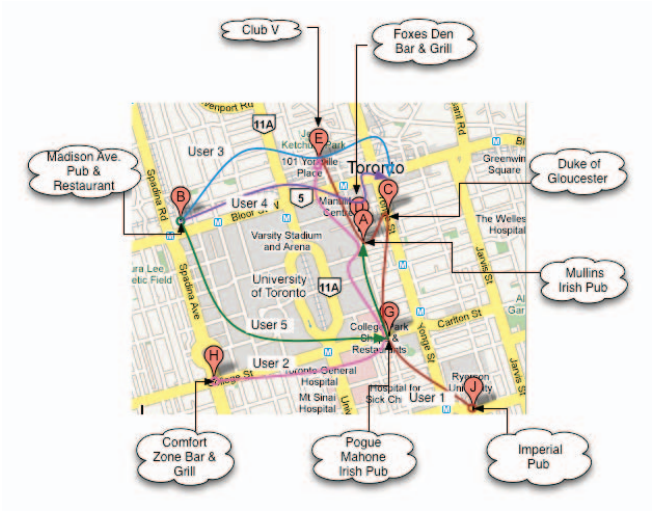


Fig. 1. Pubs and bars in downtown Toronto and tour routes.

Fig. 2 shows the flow of filtering the recommendation rules and calculating the recommendability of the rules. The algorithm first scans a list of popular bar tour routes and turns the routes (except all 1-sequence routes) into recommendation rules listed in the top left table in Fig. 2. The algorithm then transforms the recommendation rules into an array shown at the top right table in Fig. 2. Maz's route before reaching place *A* was <*J G C*>, the algorithm matches his route against the recommendation rules on every location he visited. As Maz leaving place *A*, the algorithm consults the recommendation rules and obtains the list of rules containing A (i.e., the middle left table in Fig. 2).

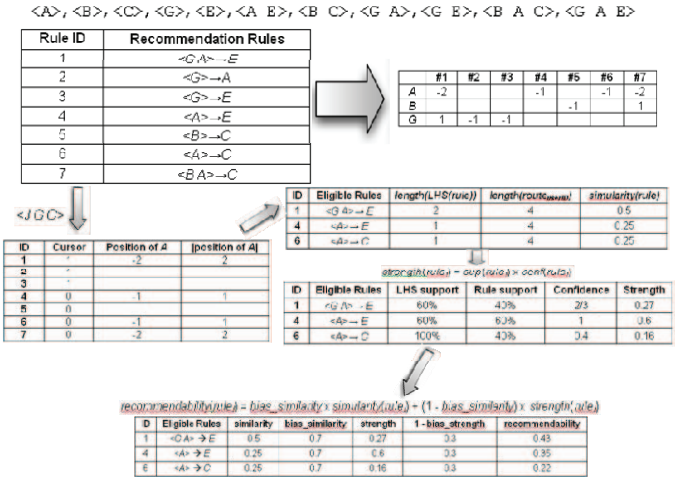


Fig. 2. Flow of recommendation rules filtering and recommendations calculation.

The rules #2, #3 and #5 are removed due to none of them contains place *A* in the pre-condition part of the rule. The absolute *cursor* values of place *A* in rule #1, #4 and #6 are greater than the *cursor* value for <*J G C*>, hence, the three rules are filtered out for further rule recommendability calculation. The details of the symbols and equations that the proposed algorithm uses can be found in [1]. At the end, the algorithm pick-up top-one highest-ranking rules' results (i.e., place *E*) as the recommendation for Maz.

III. NEXT-STOP RECOMMENDER APP

The research team would like to verify the effectiveness and the usability of the proposed algorithm; therefore, an Android mobile app – Next Stop Recommender – is implemented as the platform for data collection and pilot purpose on the later stage.

Next Stop Recommender[1] is comprised of a number of independent components. These components are developed in Java servlet and Android programming language individually. The recommender service is running at Linux server (i.e., Debian) with all other GNU General Public License servers and services. Due to one of our objectives is to allow travelers to log the places they visit (or plan to visit) in both automatic and manual way, we provide travelers both app and web user interface for their route (or plan itinerary) input.

Next Stop Recommender is a free mobile app and any traveler can download the installation file and review the video manual from the website. A traveler can self-register an account for starting to use the recommender server on the website or on the mobile device as Fig. 3 shows.

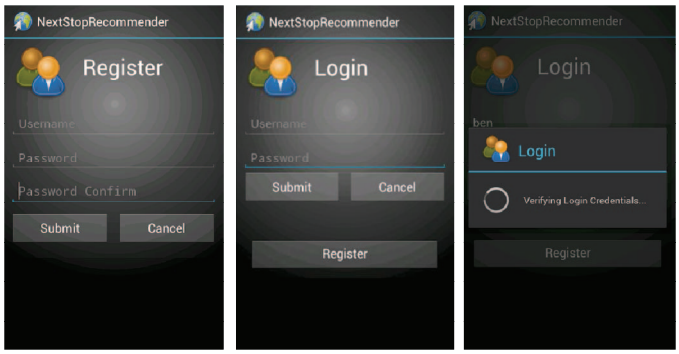


Fig. 3. Next Stop Recommender app

In order to have traveler's route data even when the traveler has no Internet access for his or her mobile device – which is common when he or she travels in another country – Next Stop Recommender app has three agents running behind the scene. Wandering behavior recorder logs time stamped positioning data; wandering data synchronizer batch updates the logged data to a centralized server; and, a service checks for internet connection so the synchronizer can start updating the logged data. A traveler is free to decide whether his or her route data being logged or not at any time by enabling and disabling the location service as Fig. 4 shows.

When the traveler enables the location service, wandering behavior recorder logs positioning data from time to time if GPS signal can be acquired as mentioned earlier. The traveler can still log his or her positioning data via QR Code scanner and manually input coordinates as Fig. 5 show.

[1] http://nextstop.dyndns.info:4735

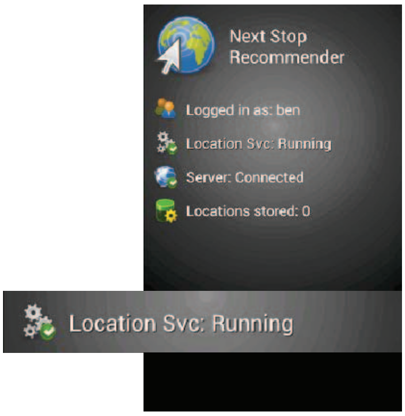


Fig. 4. Next Stop Recommender app

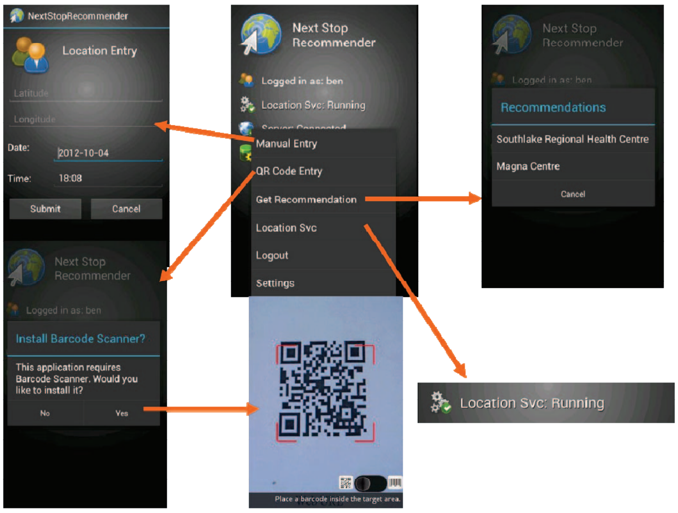


Fig. 5. Functionality of the Next Stop Recommender app

As Fig. 5 shows, the traveler can ask the app to make some recommendations for him or her at anytime via "Get Recommendation". Due to the next stop recommender algorithm needs to compare the traveler's route pattern with other travelers', the traveler needs to have Internet access at the very moment when he or she wants to get recommendation for privacy protection – no any traveler's route data will be download to anyone else's mobile device and all route pattern extraction and matching is done at the centralized server.

IV. Visualization Wandering Routes

In order to have a visit list of travelers for the proposed algorithms to find the popular bar tour routes to turn into recommendation rules, the system needs to distinguish the visit behavior and the movement behavior from the logged route data. The system applies two rules to test if the traveler is paying a place a visit or is moving from one place to another. The first rule is to check if the position the traveler is at within an effective range of a place. As Fig. 6 shows, important places in an area can be entered into the system and all places have its effective range (i.e., the radius of an area in which the important place is at the center of the area).

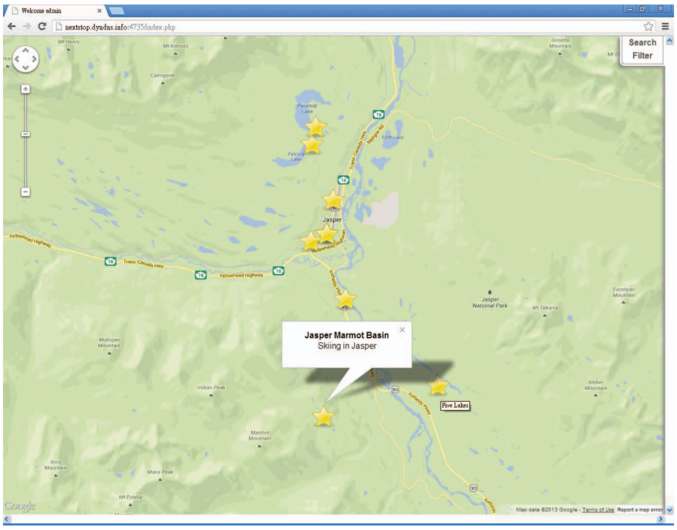


Fig. 6. Important places in an area.

The second rule is to check if the positioning data shows the traveler 'stays' within the effective range of the place for a long enough time. For instance, if the traveler is passing a place, the next couple of positioning data may not be in the effective range of the place. On the other hand, the system may 'say' the traveler is visiting the place if the very next several positioning data is still within the effective range of the place. If the place is a museum and the wandering behavior recorder may not be able to acquire GPS signal when the traveler is inside the museum, the system can still tell the time spent from the timestamp of the two consecutive positioning data. Fig. 7 shows the system identifies a traveler visited Tonquin Inn.

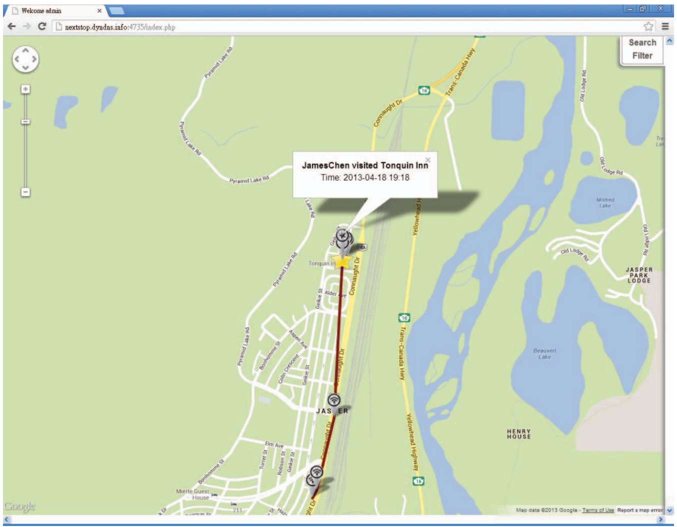


Fig. 7. A traveler visited a place.

As long as the system is capable of distinguishing whether a traveler is visiting a place or is simply passing the place, the system can generate a visit list for the traveler when he or she asks for recommendations. Sometimes the recommendations will be accepted by the travelers and sometimes won't. After the traveler asks for recommendations, the system can know if the recommendation is a successful one by checking if he or

she really pays the recommended place a visit later on. At the top left of Fig. 8, the successful recommendation icon shows the systems recommended Upper Canada Mall for a traveler and he really went to the place later.

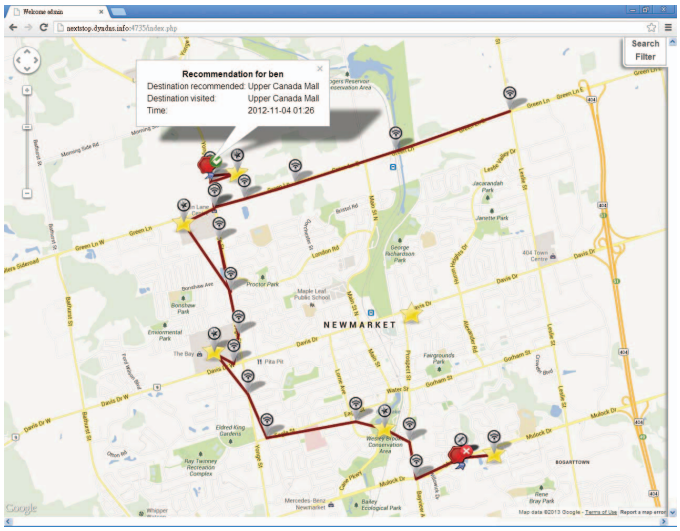


Fig. 8. Successful recommendation.

Both Fig. 5 and Fig. 8 show the evidence that Next Stop Recommender app and the proposed algorithm is offering recommendations for the traveler instead of forcing him or her to go certain place. The screenshot at top right of Fig. 5 shows the app recommends two places for the traveler. At bottom of Fig. 8, the unsuccessful recommendation icon shows the app recommended Magna Centre for the traveler but he or she went to somewhere else instead. Beside the successful and unsuccessful recommendation icons, the system also uses an unknown recommendation icon (as Fig. 9 shows) to indicate the result of the recommendation is unknown yet due to there is no further positioning data for analysis.

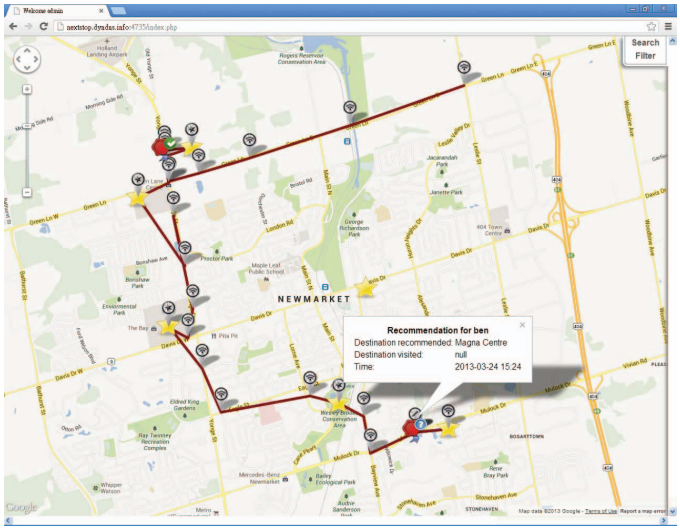


Fig. 9. The result of recommendation is still unknown yet.

At last but not least, the system is also capable of providing visualized comparison for route patterns. Fig. 10 shows two travelers' route patterns in two colors and their wandering behaviours are different: for traveler whose route is in red color, he or she visited Lowes, Costco, Upper Canada Mall, Brooks Conservation Area, and Magna Centre; and, for traveler whose route is in blue color, he or she visited Costco, Lowes, Upper Canada Mall, Southlake Regional Health Centre, Brooks Conservation Area, and Magna Centre.

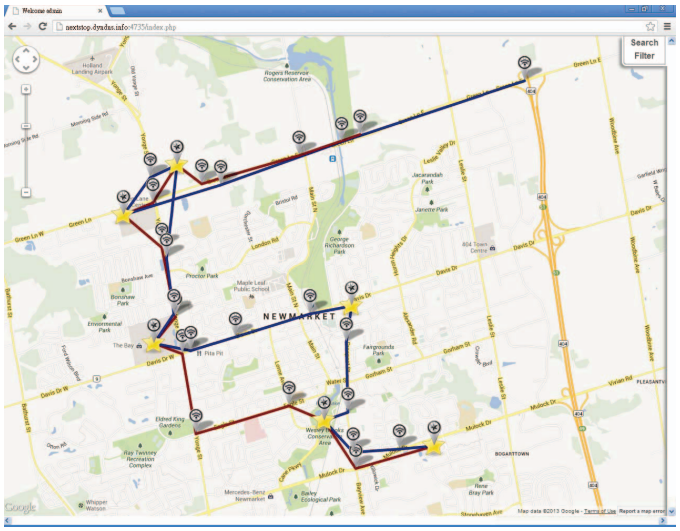


Fig. 10. Visualized comparison of two traveler route patterns.

V. CONCLUSION

The research team has designed the next stop recommendation algorithm and implemented the Next Stop Recommender mobile app for Android devices. The mobile app and the web user interface can collect sequential positioning data of travelers. The server side Java servlets can find the visit lists of travelers and summarize popular route patterns; moreover, it can turn the route patterns into recommendation rules and make recommendations for travelers. A pilot study is now needed to verify the effectiveness of the proposed algorithm and the usability of the Next Stop Recommender app.

The research has three limitations and every limitation can be seen as a future direction of the research. The first limitation of this research is that the proposed algorithm currently treats all visited places equivalent without taking the categories of the places into consideration. In such case, a non-relevant place like gasoline station or grocery store visited in the middle of a camping trip may keep the system from finding more accurate popular patterns, finding recommendation rules and making appropriate recommendations.

The second limitation of this research is that the important places (as Figure 6 shows) are manually entered into the system now. The system should be capable of importing the point of interests directly from the map service provider. With such enhancement, the travelers in world wide will benefit from the research.

The third limitation of this research is the lack of considering social effects while making recommendations for travelers. For instance, a traveler may change his or her mind to pay a particular place a visit because he or she finds hundred thousands of other travelers went to there before or hundreds of travelers 'Like' the place. As the system is now capable of being aware of whether the recommendations are taken by the travelers or not, it can let the traveler know how many travelers before him or her had accepted the particular recommendation. In such case, the social effects of a recommendation can be measured and the recommendation algorithm can be revised to a more adaptive one to provide travelers better personalized service.

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