Activity Model using Location and Places' Attributes for Navigation Services

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Abstract

This paper proposes a new way to construct an activity model which represents users' habit while users move in his/her daily life. In recent years, we can acquire users' more precise location using GPS. We represent users' habit by analyzing the users' location history data. The representation of the habit enables computers predict users' destination and adjust a sight-seeing path. Existing activity models can be adapted only for a usual activity area, although users' habit is independent for usual activity area or location. In this paper, we propose a new activity model, which uses not only users' location but also attributes of the place where user stayed. This model can be used in the first visited area as well as represent users' habits.

1. Introduction

We can obtain precise location information exploiting GPS because of the elimination of restriction on the system. It is enough accurate to distinguish where the user stands in front of which shop. In addition since GIS (Geographical Information System) has been developed, we can exploit meta-information of location such as coordinates of rods, a name of buildings and their labels. Exploiting these systems, location-aware services have been developed that provides helpful information to users. In psychological domain, it is defined that there are habits in usual human activities [4]. A habit is a regularity which humans act under a particular condition such as location or time. For example, "A user goes to cafeteria after goes to the restaurant". Modeling the human habit makes computers provide helpful services corresponding to the human activity.

As an example of helpful service for daily situation: Assuming a user goes restaurant A, after that, goes cafeteria B. And now, the user is in restaurant A. Then, a system can support the user's next activity by displaying information like the shortest path to the cafeteria B, congestion degree and available time. In unusual situation, if a tour path conductor system exploits users' activity model, the system can propose unusual activity or usual activity whichever the user wants.

It has been proposed the ways to construct activity model [1] [3]. However, when users stayed the first visited area, the users want to act same as daily activity. Like looking for cafeteria a user usually goes. Existing activity model can construct in the only area where usual acting area. So users can't be served benefits of location-aware services which use activity model in the first visited area. The problem in existing modeling methods is that they use only coordinates to represent users' location. According to the problem, in the area where users visit first, the users' activity model needs movement history in the new area.

In this paper, we propose a Model for User activity using Geographical Information (MUGI). MUGI enables us to serve location-aware service corresponding to users' habit in first visited area. Activity model treats historical movement, so system must scale and operate fast.

2. MUGI

It is needed to weaken the relation between location and activity model to exploit activity model in the first visited area. We used not only location but also places' attributes to construct activity model. Places' attributes are meta-information of location and area. The reason to focusing on places' attributes is the one of changing contexts when user moves. So we constructed activity model using those contexts.

There are several abstraction levels for places' attributes in GIS. For example, we explain *McDonald's*, which has five abstraction levels as follows; the first is the most specific, the last is the most generic.

- *McDonald's* in Ginza
- *McDonald's*
- Fast-food
- Eating and drinking
- Stores

MUGI provides activity prediction and activity evaluation. Activity prediction indicates the place where user will go for the next. Activity evaluation judges suitability of prepared paths.

3. Design and Implementation

3.1. Design

In this research, we use Hidden Markov Model (HMM)[2] to construct MUGI, which model can express probabilistic automaton, holds state transition, can output probability. The reason of adapting HMM is to express movement patterns between the places users stayed. The places' attributes is represented as a node in HMM.

Initial state of MUGI is organized only special node. The special node saves specific attributes in the usual activity area, like school, home and working office. This special node is not used prediction and evaluation in the first visited area. The other nodes constructing MUGI is made dynamically when user visited a new attribute's place. At the same time of making nodes, make a relation between nodes.

3.2. Implementation

We implemented the CHOCO (Figure1) which constructs MUGI using Java. And we implemented a platform which enables services to exploit MUGI. Figure2 shows a snapshot of the platform. The right-bottom panel shows current MUGI status. The boxes in the panel represent nodes, line represents state transition and the numbers next to the line represent probability of the transition. Internal attributes are showed above on the node by clicking a node. The right-top panel shows map and current location. Left side panel shows applications which is developed by a application provider. Applications are changed by selecting tab.

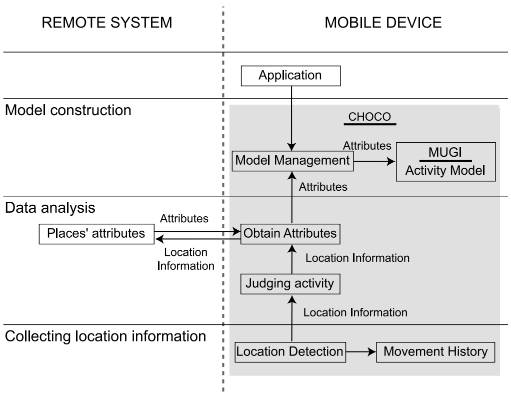

Figure 1. System design

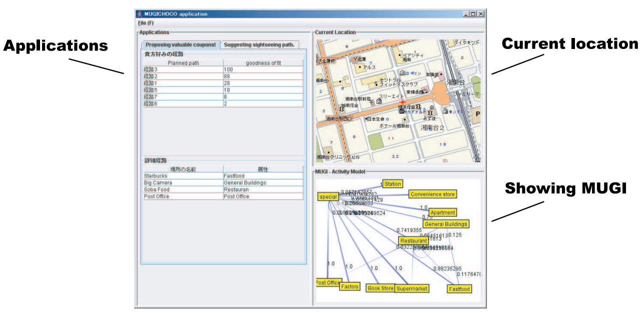

Figure 2. A snapshot of MUGI

4. Evaluation

4.1. Qualitative evaluation

Existing research to construct activity model like "Learning Significant Location and predicting User Movement with GPS[1]" and "Inferring High Level Behavior from Low Level Sensors[3]" are not able to use the first visited area. They enable precise activity prediction using movement history in a specific area. So they can't predict first visited area. MUGI constructs activity model using places' attributes which is more abstract information than location information. So MUGI can't predict users' movement precisely, but it can predict in the first visited area.

4.2. Quantitative evaluation

We evaluated CHOCO's scalability and operation performance. We have used 178 stay points of movement history, accumulated 62 days for the input for CHOCO.

We measured execution time of prediction and file size to save a MUGI image to evaluate operation performance. Maximum of execution time is 16ms, enough fast, because of the model is small, and we implemented MUGI to map on the physical memory. We have made MUGI learn for assumed 100 years movement calculated from 62 days movement to evaluate scalability. File size become about 1.1MB even input 100 years data. MUGI scales enough to save current mobile device such as PDA and cell phone.

5. Conclusions and Future work

In this paper, we proposed activity model, MUGI, using place's attributes. As an evaluation of MUGI, we confirm that MUGI scales and operates fast.

We are considering model sharing with other MUGI and making a transition weight to be more useful. Regarding model sharing, in the situation of more than two people using MUGI, each user's MUGI calculates its own prediction. MUGI should be synthesized with the other users' MUGI. Population parameter will increase with getting build up a activity model. So the one movement's effect weight will affect less with getting learned. So we need to treat transitions distinguishing old one and new one.

6. Acknowledgments

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