Time, Place, Purpose and Personal Profile Based Information Retrieval for Recommendation Service in Mobile Environment

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Abstract

Most information service today considers about location-based service or time service. However, it has more factors that make system achieve more efficient service. In this paper, we propose the relationship of time, place, purpose, preference and short time history. The three factors which time, place and purpose are mutually dependent which we have summarized the basic rules to analyze essential data. We are filtering the message with important factors are preference and history. We illustrate scenarios about "push", "pull" and "don't disturb mode" service in Odaiba area, which our DB queries can be recommended relevant messages to users. Furthermore, we discuss the implementation of prototype system including results of experimental evaluation.

1 Introduction

Currently, the mobile phone has become an integral part of our private life. More and more people have started using mobile phone not only to communicate with each others but also to access the information they need from every place and every time. Moreover, a variety of services and tremendous information have been recommended to customers. Because mobile phone contains such sophisticated communications though so small-sized which means limited memory and a narrow monitor. As a result, the limitation in displaying details and system must use only essential data in process. Therefore, algorithm for selecting information to user is very important. The handling of user preference is becoming increasingly important factor in current information system. Preferences are used for filtering to reduce the volume of data presented to the user.

In this paper, we will propose the solution based on the following:

Time, place, purpose factors: The three factors of each person with each activity are different. So, our service is based on these factors, each data of which we collect to summarize rules and essential data.

Push, pull and don't disturb services: Our system has three services: push, pull and don't disturb. Push and don't disturb services are automatically performed by the system in the service area to mobile phone users who have registered with the system, while pull service is performed by mobile phone users.

Preference and history: Each person has a different preference; therefore we create a personal profile database to store preference data of each person. However, in sometime has a special activity. The system will use short time history to extract data. That means the system takes personal profile and short time history into consideration and makes messages that have been filtered and will not be a spam.

Experimental result: The proposed mechanism has been implemented as a prototype system and is discussed through the results of experiments.

The rest of this paper is organized as follows. Section 2 briefly discusses related work. In Section 3 we present time, place, purpose and personal profile based requirement by illustrated motivation scenarios. Section 4 analyze scenarios and summarize basic rules to interpret data. We describe our algorithms to process queries in an efficient way. In addition to, we exemplify "push", "pull" and "don't disturb mode" service. Section 5 we present the implementation of a prototype system including discuss results of experimental evaluation. We come up with a conclusion and future work in Section 6.

2 Related Work

In this section we briefly present some of business and research approaches related to information service and personalization.

Amazon.com™ is an online store, which records personal profile such as favorite areas, customer history and rated items for personalized recommendations service. Besides these, customers can edit their profile as well. Moreover, customers can create a wish list and let their friends as well as family know about their wish list.

NTT DoCoMo, Inc. provides DLP service (DoCoMo Location Platform) which uses GPS (Global Positioning System) that lets users quickly pinpoint their location, within a radius of 50 meters, and download area maps and information. The provisions of GPS include public transportation, restaurant data as well as routing to help navigate to specific locations.

Kießling et.al. (2002) proposes preference SQL extends SQL by a preference model based on strict partial orders. The Preference SQL optimizer does an efficient re-writing into standard SQL, including a high level implementation of the skyline operator.

As another interesting approach, Koutrika et al. (2004) proposes a personalization framework based on user profiles. Preference model assigns personal degree of interest. Query proceeds in two steps: preference selection and preference integration.

In our previous research (Pinyapong and Kato 2004) proposed query processing algorithms of four factors which are time, place, purpose and personal profile. We summarize relationship between three factors in basic rules. However, we found the drawback of system. In this paper, we develop algorithm to filtering data by personal profile, category and short time history. Moreover, we also use community information for useful recommendation.

3 Motivation Scenarios

In our everyday life, we rely on various information on working, studying, researching, shopping and traveling. Such information has become an integral part of our life. One day in the morning we obtain news from online newspaper services, contact customers via e-mail at workplace in late morning, collect data to present in the afternoon meeting, choose a gift for special event and watch a television at home in evening. We are concerned with information altogether. However, the difference in time, place, purpose and profile to bring about also necessitate different information. Therefore, not only information has become a part of life, but also time, place purpose and profile are important factors. The following scenarios illustrate our vision of recommendation for future mobile services that involves with time, place, purpose and profile factors.

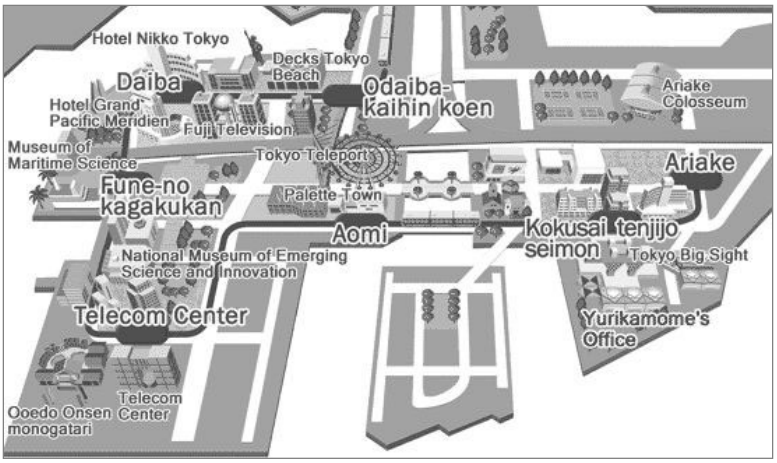

Figure 1: Odaiba Map

Odaiba is a popular shopping and sightseeing destination for Tokyoites and tourists.
Some major attractions include:

- Fuji TV Studios
- Aqua City: Gourmet & Shopping
- Museum of Maritime Science
- National Museum of Emerging Science and Innovation (MeSci)
- Venus Fort: a Venice-themed shopping mall
- Oedo-Onsen-Monogatari: Hot springs
- MEGA WEB: TOYOTA Car Theme Park

- *Push service*: Mr. A visits National Museum of Emerging Science and Innovation (MeSci) at Odaiba. Two hours later, he doesn't know where he will go next. Accidentally today is the last day of "Free riding a car Fair" at MEGA WEB. At the same time "Lady Fashion Sale" at Aqua City is also taking place. From Mr. A's profile, it turns out that he likes a car more than shopping then the recommendation service starts. While he is walking in MeSci, he gets a message saying that MEGA WEB is on the last day of its special event "Free riding a car Fair".

- *Pull service*: After Mr. A has studied at MeSci for about two hours, seen and ridden a car at MEGA WEB for one hour, he gets tired and wants to be relaxed and thus he searches via the mobile phone's system for a relaxing place. The system recommends a night fee at Oedo Onsen Monogatari before 6:00 pm. He wants to be relaxed and thus he goes to Oedo Onsen.

- *Don't disturb service*: Ms. B's mobile phone automatically change to don't disturb mode for three hours since she visits Fuji TV Studios at 12:30pm. At 3:30pm she gets a message informing about "Lady Fashion Sale" at Aqua City starting from 4:00pm. Aqua City is opposite to Fuji TV Studios and thus she decides to go to Aqua City.

From above scenarios, if the recommendation system is complete with detection of time spent for Mr. A at MeSci. and using Mr. A's profile for pull service, with being able to detect don't disturb service for Ms. B switched off as well, the system can provide *push, pull* and *don't disturb service* information fulfilling customer's satisfaction.

4 System Mechanisms

From above scenarios, we propose three services as follows:
1. Push service: performs when the mobile phone user arrives at Odaiba area.
2. Pull service: performs when the mobile phone user tries to access a mobile service.
3. Don't disturb service: not recommend any message to mobile phone user when he/she visits some place with a clear purpose and spends some time.

4.1 Rules

4.1.1 Time, place, purpose

In this section, we analyze scenarios according to a mechanism to summarize basic rules. In addition, we create algorithms to process recommendation service.

From scenarios, Mr. A goes to MeSci museum where he could learn something new. As he has to pay a fee, we assume that Mr. A has a specific purpose to visit there and spends about two hours over there. The system doesn't recommend anything during two hours because doing so can disturb him. Nevertheless, it will recommend something two hours later. In addition, it retrieves Mr. A's profile indicating that he likes a car. Consequently, it recommends "Free riding a car Fair" at MEGA WEB to him.

As Mr. A gets tired, he will next search via the mobile phone system for a relaxing place. From his profile and arrival time calculation, the system recommends Oedo Onsen Monogatari to him.

As another event, Ms. B goes to Fuji TV Studios since 12:30pm. The system checks with basic rules and detects an interval time of three hours. Then recommendation time will be three hours later. At 3:30pm no preference data from her profile matches the event, thus the system considers to recommend "Lady Fashion Sale" at Aqua City because she can go there in time. we can analyze factors as shown below:
(1) *Time*: Time depends on the purpose and place. For example, it takes two hours or more to go to a museum, and going to Oedo Onsen Monogatari spends longer time as it takes about four hours or more or going to shopping can spend unlimited time.
(2) *Place*: Place depends on the type of place, position as well as a charge of fee. Otherwise, distance and traffic time will be considered.
(3) *Purpose*: "Clear purpose" such as seeing an exhibition and watching a movies will consume a different amount of time from "unclear purpose" such as strolling and shopping. For instance, when a customer is enjoying himself in an amusement park for a long time, if the system pushes a message, it possibly becomes a spam. On the other hand, when customer doesn't have any clear purpose, if the system pushes a message, it may be interesting to him.

From analysis above factors, three factors are mutually dependent. Then, we can summarize relationship between time, place and purpose in basic rules as shown in Table 1.

Table 1: Example of basic rules

AMOUNT OF TIME	CHARGE	PURPOSE	ESTIMATE INTERVAL TIME	ACTION
Museum	Yes	learning, new knowledge	< 2 hours	Not to recommend
			≥ 2 hours	Recommend
Hot springs	Yes	relaxation	< 4 hours	Not to recommend
			≥ 4 hours	Recommend
Amusement Park	Yes	enjoyment, entertainment	< half day	Not to recommend
			≥ half day	Recommend
Shopping mall	No	purchase or observation	0	Recommend anytime

4.1.2 Preference

In this section, we will describe preference algorithms which are used to filter information presented. The attributes that we consider are as follows:

- *User Preference:* We collect interesting data of each user and have been stored in the database.
- *Category of preference:* The preferences of each user are divided into category and category hierarchy.
- *Degree of preference*: Degree of preference express level of interesting, which in the range [0, 10]. 0 indicates lack of interest, while 10 indicates much more interest.
- *Budget*: We also use a budget that user can expend on recommending proper information.

From category of preference, each level of category has relative and mutually dependence that means functional dependency. Thus, we calculate degree of interest from degree of preference from category hierarchy.
Example: Mr.A's preference category and degree of preference are

Restaurant (5)→ Japanese food (4)
→ Chinese food (5)
Fashion (6) → elegance (3)
→ casual (4)

The degree of interests can be calculated from product of degree preference in the same category hierarchy. Thus, degree of Japanese food is (5*4) = 20, Chinese food is (5*5) = 25, elegance fashion is (6*3) = 18 and casual fashion is (6*4) = 24.

We use a degree of interest to rank recommendation results that closely match user preference.

4.1.3 Short time history (log)

Besides time, place purpose and preference, short time history is also an important data. It consists of useful data such as special action and log data. The advantage of short time history will be that it can provide more efficient service.

In some day, the user has a special activity that not as usual his/her preference. For instance: shopping for mother that means not use his/her preference data but use short time history instead. In addition, today so feel sleepy then want to drink espresso instead café au lait. This situation is also use short time history data.

Therefore, the system has an interface to interact with the user and store interaction data in log file. The system uses this data to filtering a message and can recommend near matches to special activity in such day.

4.2 Push Service

When the mobile customers who have registered with the system arrive at Odaiba area, Global Positioning System (GPS) technology available in the mobile networks has already checked customer's position. The system uses this information to connect to the server and accesses the database to retrieve events that match the condition. Finally, the system pushes a message to a mobile phone customer. The algorithms used can be explained as follows:

The database is described by the schema below, where primary keys are underlined.
CUSTOMER (*id, mobile_mail, name, mobile*)

EVENT (*event_id, event_name, place_name, detail, budget_min,*
budget_max,date_start,date_stop,time_start, time_stop)
PLACE (*place_id, place_name, type_place, station*)
PREF (*prefid, id, prefer, degree, budget_min, budget_max*)
PURPOSE (*purpose_id, place_id, charge, aim, interval_time*)
TRAFFIC (*id, start, stop, time*)

Example 1:
Mr. A arrives at MeSci museum at 1:00pm.
1. Checks a purpose and estimate interval time with the basic rules. MeSci museum charges a fee. Therefore, the system presumes that Mr. A has a clear purpose of visiting there and the interval time is not less than two hours.
2. Interprets data to build a DB query as follows:

```
SELECT  event_name, place_name, date_start,
        date_stop, event_time, time_start, time_stop
FROM    event, place
WHERE   place_name = 'MeSci' and
        (date_start >= 'today' or date_stop >= 'today') and
        time_start > 'now' + (SELECT interval_ time
                              FROM  purpose
                              WHERE place_id = 1);
```

3. Executes the DB query.
Output:
(1) "Free riding a car Fair" 4:00pm at Mega Web
(2) "Lady Fashion Sale" 4:00pm at Aqua City
(3) "Sea World" 3:00pm at Museum of Maritime Science
4. Filters into a recommendation message.
Retrieving user preference data from the Personal DB:

```
SELECT  pref.id, prefer, degree, budget_min,
        budget_max, mobile_mail
FROM   pref, customer
WHERE  pref.id = '"+ 'A' +"' and customer.id=pref.id
ORDER BY degree desc;
```

Filtering with preference, degree, budget and short time history:

```
SELECT  event_id,event_name,place_name, detail,date_start,
        date_stop, time_start, time_stop, budget_min, budget_max
FROM    event
WHERE   place_name <> '"+'MEGA WEB' + "' and
        detail LIKE '%" + 'Onsen' + "%' and budget <= 2000
        (date_start >='today' or date_stop >='today');
```

Mr. A prefers "car" and thus the system will push a message " Free riding a car Fair" to him.
5. Pushes a message.
The system pushes a recommendation message obtained to Mr. A.

4.3 Pull Service

A mobile phone customer who has registered with the system accesses via their mobile phone to search for services or events by keywords. The system is responsible for creating complete DB queries from the keywords. The smart engine interprets data to build DB queries, which retrieve events that match the keywords from the database. Finally, the system sends recommendation messages to that mobile customer.
Example 2:
Mr. A searches for a relaxing place via the system running on his mobile phone. The system recommends a night fee at Oedo Onsen Monogatari before 6:00 pm.
1. Searches by keyword:

Position: MEGA WEB, time: 5:00 pm, keyword: “relax”
2. Interprets data to build a DB query as follows:

```
SELECT map, place_name, event_name
FROM  place, event
WHERE position_now = “MEGA WEB”
        date_start  <= “today”,
       time_start >= “now” ;
```

3. Executes the DB query.
Output:
(1) “Special night price” before 6:00pm at Oedo Onsen Monogatari
(2) “Aromatherapy oil massage” before 10:00pm at Thai Massage, Aqua City
4. Filters into a recommendation message.
Connects to the Personal DB to retrieve user preference, and then filters with preference, degree, budget and short time history in the same way as the push service.
Filtering with preference, degree, budget and short time history:

```
SELECT event_id,event_name,place_name, detail,date_start,
        date_stop, time_start, time_stop, budget_min, budget_max
FROM   event
WHERE  place_name <> '"+'MeSci' + '" and
        detail LIKE '%" + 'CAR' + "%' and budget = 'free'
        (date_start >='today' or date_stop >='today');
```

Mr. A prefers “Onsen” and thus the system selects a message “Special night price” at Oedo Onsen for him.
5. Pushes the recommendation message.
The system sends a message to Mr. A.

4.4 Don’t disturb service

When customers go to a certain place with a particular purpose or that place charges a fee, the system can check with basic rules in Table 1 to estimate an interval time. The interval time is a control time that the system uses to consider not to disturb the customers with any unnecessary message. Later, the system will push a message after “don’t disturb time” has been elapsed. In this case, the push service is the same as the one described in Section 3.2
Example 3:
Ms. B arrives at Fuji TV Studios at 12:30pm.
1. Checks a purpose and estimate interval time with the basic rules. Fuji TV charges a fee. Therefore, the system presumes that Ms. B has a clear purpose of visiting there and the interval time is not less than three hours. Therefore, the recommendation time will be 3:30pm.

As a result, the system does not recommend anything during these three hours, which is called “don’t disturb time”, and the user can receive pushed messages again after this “don’t disturb time” has been elapsed. The system estimates the interval time and waits for the right pushing time.

5 Implementation and Evaluation

5.1 Implementation

In order to evaluate the proposed framework, we have implemented a prototype system. On mobile phone, user interface was developed for i-mode and EZweb phone in Japan.(Figure 2 and 3)

Figure 2: User interface for interacting with system

The web application server that recommends message to users is Tomcat 4.1.24 Servlet/JSP container. The system communicates with all users via Java mail. The RDBMS used to store data and profile is PostgreSQL7.3.2 on RedHat 8.0 (Linux Kernel 2.4.18) operating system environment. J2EE programming has built a smart engine to calculate and derive essential data for the DB query. Furthermore, the J2EE application communicates with the database via JDBC.

Figure 3: GPS pinpoint user's position

The implementation described in Figure4. Minimal requirement in mobile phone is:

- GPS data
- Current time
- Recent history
- Partial of personal profile data such as: id, sex, occupation, hobby, like, dislike

Customer position has been pinpointed by GPS. Mobile phone data has transfer to service provider via network. Service provider in server side composed of smart engine, complement SQL command including Database server.

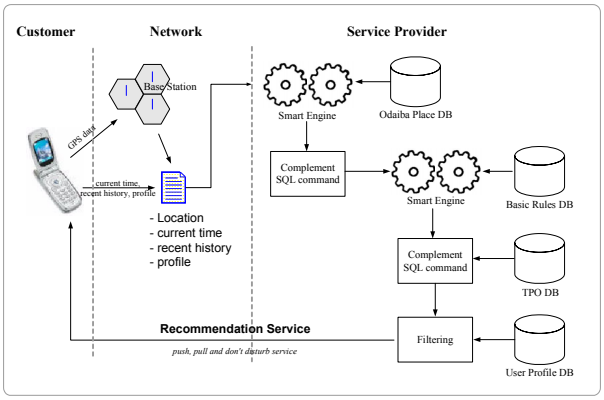

Figure 4: Implementation system

We describe detail of each component as follows.
Smart Engine: checks position from Odaiba Place DB and check place, purpose from Basic Rules DB as well as calculates the interval time to spend at such place.
Complement SQL command: Derived data from smart engine is being interpreted to fulfill Database queries. Then queries access for retrieving events in addition to execute with TPO Database.
Database Server: The schema described in figure1 represents actual database that was created for the experiments and contain information about Odaiba Place DB, Basic Rules DB, TPO DB and Personal DB. Those are stored in a separate database.

5.2 Evaluation

The evaluation experiment of the system was conducted by group of mobile users at Odaiba in Japan. The subjects of the experiment are separated into two groups over two days.

The users had already registered with the system, and preference data that we acquired from the questionnaire before the experiment had been stored as well. The users were sent recommendation messages to join three interesting events via their mobile phone.

In the first day, we used a main preference (among three preferences) of each user and degree of preference in the personal profile database. We also prepared questionnaires to obtain satisfaction level data from each user.

In second day, we examined in the same way as the first day but used main three preferences (among five preferences) of each user. As a result, there were various recommendation messages and users had more choices. Furthermore, in second day we improved the user's preference database and filtering mechanism and thus users could obtain proper messages and more satisfaction.

In addition, in second day the percentage of users who accepted recommendations and marked their satisfaction of "much more satisfied" and "more satisfied" levels increased by 13.16%, while the percentage of "less satisfied" and "much less satisfied" levels decreased by 33.96% (Table 2 and Figure 4).

Table 2: Satisfaction level of visited invitation message users

Satisfaction level	First day[*1](%)	Second day[*2] (%)
Much more satisfied (5)	15.91	22.99
More satisfied (4)	29.55	35.63
Satisfied (3)	9.09	29.89
Less satisfied (2)	15.91	5.75
Much less satisfied (1)	29.55	5.75

[*1]) mainly use one preference from 3 preferences
[*2]) mainly use three preferences from 5 preferences

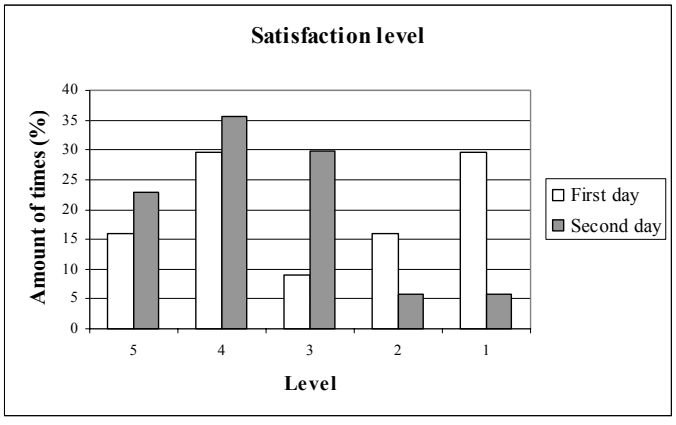

Figure 4: Satisfaction level of visited invitation message users

6 Conclusion

In this paper, in order to have more efficient recommendation service we have proposed:
1) Time, place, purpose: the mutually dependence of these factors which we can summarize the basic rules to control external factors. Otherwise, these factors can answer when, where and how to recommend information or service to customers.
2) Push, pull and don't disturb mode service: we illustrate on motivating scenarios which are specific example and can show our idea as well as more details of relationship between time, place, purpose and profile.
3) Preference and history: we are collecting each personal profile such as user preference, category, degree, budget and short time history to filtering messages into recommendation.

We have implemented and evaluated our prototype system. In this step make we understand strong and weak points of experiment. We continuously improve and develop for high level recommendation. Furthermore, we also conclude the general rules which can apply in anyplace for usefulness in our daily life.

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