無線環境中建立推薦系統之研究　計畫報告

報告內容

A Recommender System for Mobile Shopping Environment

1. Introduction

Mobile computing, where users equipped with PDAs, cellular phones, or laptops are free to move while staying connected to service networks, has proved to be a true revolution (Stafford and Gillenson 2003). Exploring the promises of mobility in designing new applications and services that automatically accommodate customer's shopping needs with location-dependent vendor offers and promotions has generated considerable excitement among both commercial companies (e.g., HP, Nokia, and Samsung) and academics (e.g., Brunato and Battiti 2003; Sun 2003; Tewari et al. 2002; Tsang et al. 2004).

One of the most popular tools provided in e-commerce to accommodate customer shopping needs with vendor offers is recommender systems (CACM 1992). Traditional recommendation techniques, however, are not fully suitable in mobile shopping environment. M-commerce is unique in its location-aware capability (Stafford and Gillenson 2003). Mobile computing adds a relevant but mostly unexplored piece of information – the customer's physical location – to the recommendation problem. Personal recommendations in m-commerce provide the opportunity and the challenge to take location into account. Therefore, in this research, we propose a location-aware system for recommending vendors' webpages in a mobile shopping environment.

The proposed personal recommender (PR) system is designed to recommend vendors' webpages (including offers and promotions) to interested customers. The PR system adopted a location-aware architecture so that customers can receive the information of their preferred vendors that are in their neighborhood. The core of the PR system is a recommendation mechanism that analyzes a customer's history and position so that vendor information can be ranked according to the match with the preferences of a customer. Various characteristics of mobile shopping environments are taken into account, and the resulting system can be applied to m-commerce.

2. Literature review

Due to the increasing adoption of mobile devices, location-aware systems are becoming more widespread and the demand for them continues to grow. These

location-aware systems use the estimated position to provide various services. For example, the "Active Badge Location System" proposed by Want et al. (1992) is considered one of the first location-aware applications. This system used infrared technology to determine a user's current location, which was used to forward phone calls to a telephone close to the targeted user. The "Personal Shopping Assistant", proposed at AT&T (Asthana et al. 1994), provided an indoor wireless system for personalized shopping assistance. The Cyberguide system (Long et al. 1996), developed by the Future Computing Environments group at the Georgia Institute of Technology, used wireless transmissions and GPS to build mobile tour guides that provided information to tourists based on knowledge of their positions and orientation. This system has been extended to support conference attendees by providing them with appropriate information via a PDA as they navigate conference rooms (Dey et al. 1999). Several other tour guides (e.g., Davies et al. 1999; Kreller et al. 1998; Cheverst et al. 2000) have also been proposed.

E-commerce has seen the emergence of many types of recommender systems that are designed to provide personal recommendations about various types of products and services (CACM 1992). The first type of recommendation techniques was called the *content-based approach* (CACM 1992). The basic idea of content-based approach is to recommend products according to preferences of customers. Content-based approach characterizes recommendable items by a set of content features and represents customers' interest profile by a similar feature set. Then, the relevance of a given content item and the customer's interest profile is measured as the similarity of this recommendable item to the customer's interest profile. Content-based approach selects recommendable items that have a high degree of similarity to the customer's interest profile. Another type of recommendation technique, the *collaborative approach* (or sometimes called the *social-based approach*), takes into account the given customer's interest profile and the profiles of other customers with similar interests (Shardanand and Maes 1995). The collaborative approach looks for relevance among customers by observing their ratings assigned to products in a relatively small training set. The nearest-neighbor users are those that are most relevant to the target customer. These customers then act as "recommendation partners" for the target customer, with the collaborative approach recommending to the target customer items that appear in the profiles of these recommendation partners but not in those of the target customer. Although these two types of recommender systems have achieved certain success in e-commerce, an important piece of information in m-commerce – the customer's location – has not been exploited in previous recommender systems.

There is a pressing need to make it easier for mobile users to obtain their desired information at the right time and in the right place (Sun 2003). Sun (2003) proposed the IRE (Information Requirement Elicitation) framework to help users specify their requirements and filter suppliers by their contextual relevancy to users. Websigns, proposed by HP (Pradhan et al. 2001), sends the user's position to a central server that extracts all supplied items whose direction and distance fall within some item-dependent intervals. Brunato and Battiti (2003) assume that a mobile user is likely to interact with a PDA only for the time that is strictly needed to find certain interesting information, and hence proposed the PILGRIM system in which each webpage is associated with a location ellipse derived from previous user's access logs, with webpages recommended when the user is located within the corresponding ellipses.

3. Research result

The overall architecture of the PR system is shown in Figure 1. The client side comprises two components: (i) a standard Internet browser and (ii) the location manager that estimates the client's position. When a customer needs the recommendation service, a request is sent with the customer's position to the server. On the server side, the core is the recommendation engine consisting of off-line and on-line subsystems. The off-line subsystem maintains a database, WEB ACCESS, that logs data about what webpages have been visited by each customer. This subsystem also analyzes the logged data and derives the profile of each customer's interests. The on-line subsystem maintains the customer profiles plus a database, VENDOR DATA, containing vendor's information, such as name, physical address, and webpage link, which is directly registered by vendor. When receiving a service request, the on-line subsystem generates a list of possibly interesting webpages based on the customer's interests profile, vendor data, and the instantaneous position of the customer provided by the location manager.

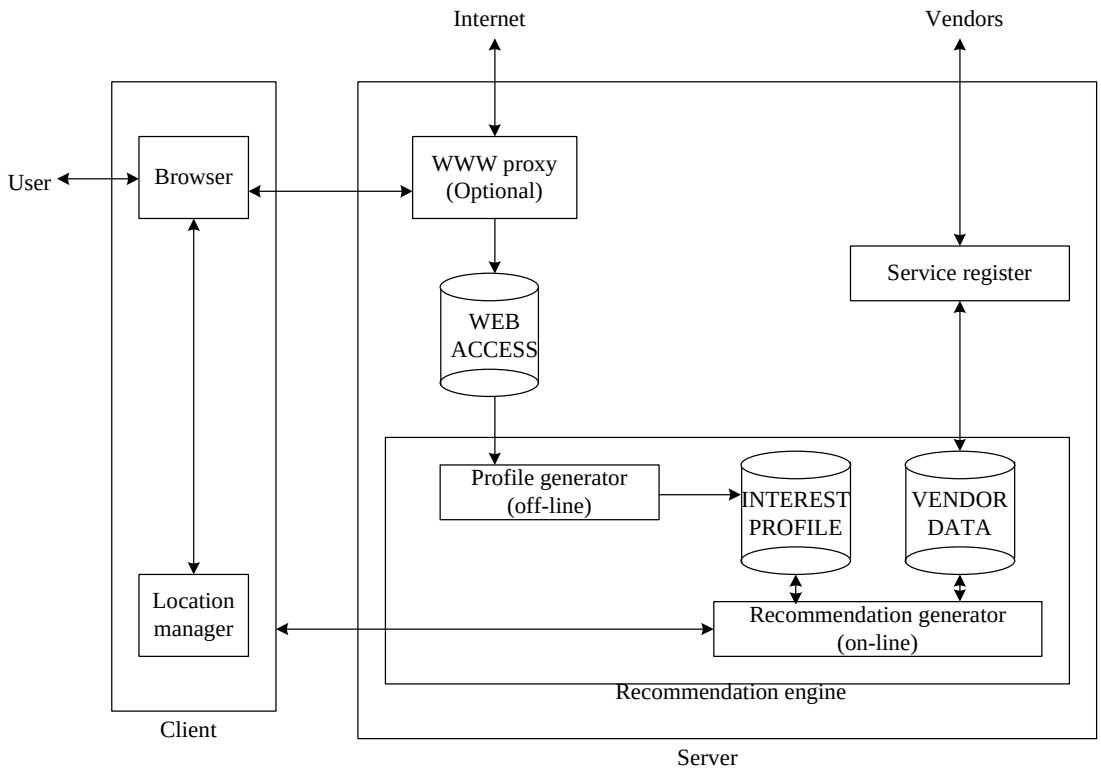

Figure 1. Architecture of the PR system

Once the WEB ACCESS database is populated with past customer accesses to webpages, its data can be used to estimate a customer's interest profile. The PR system applies a simple information extraction method (Kushmerick et al. 1997) to the visited webpages. The profile of interest of each customer, which is learned from the webpages that the customer has visited, is represented as a vector of terms that are created by the system by summarizing the webpages that he or she has visited. Therefore, if a customer *c* has visited a set *S* of webpages, the interest profile of customer *c* is estimated using

$$\mathrm{CP}(c) = \sum_{w \in S} \mathrm{Vector}(w) \qquad \text{(Equ1)}$$

, where Vector(*w*) denotes the term vector of webpage *w*.

Based on the generated profile of a customer's interest, the PR system estimates the customer's interest in the webpage of a particular vendor based on the similarity of the webpage to the customer's interest profile according to

$$\mathrm{Similarity}(c, w) = \mathrm{Cosin}(\mathrm{CP}(c), \mathrm{Vector}(w)) \qquad \text{(Equ2)}$$

The physical distance between the customer and vendor is also considered by the PR system. Each webpage registered by a vendor is assigned a physical location. We posit that the likelihood of a vendor being visited by a customer falls exponentially with the distance between them:

$$\text{DistanceDecay}(c, w) = \frac{1}{e^{\lambda \times \text{Distance}(c,w)}} \quad \text{(Equ3)}$$

where $\lambda \in [0,\infty]$ is a parameter representing the customer's sensitivity to location, and Distance(c, w) denotes the Euclidean distance between customer c and webpage w. Therefore, the interest of customer c in vendor's webpage w at the customer's present position is

$$\text{Interest}(c, w) = \text{Similarity}(c, w) * \text{DistanceDecay}(c, w) \quad \text{(Equ4)}$$

Parameter λ ranges from 0 for a customer who does not care about a vendor's location to ∞ for a customer who is infinitely sensitive to a vendor's location. A procedure for determining the most suitable λ for each customer was also designed and implemented in the location manager. The PR system generates a recommendation list containing the top-N webpages for the requesting customer.

The different building blocks of the PR system shown in Figure 1 were implemented and integrated with GPS technology in this study. The separate components were written in Java, interact with standard HTML, to generate the recommendation list for customers. We applied our proposed approach to both synthetic and empirical data for evaluating the efficiency and the effectiveness of our proposed approach.

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計畫結果自評

本計畫研究成果大致與原計畫相符。本研究成果已投稿於 Expert Systems with Applications 期刊，並為期刊所接受刊登。