A Novel Collaborative Filtering-Based Framework for Personalized Services in M-Commerce

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ABSTRACT

With the rapid growth of wireless technologies and handheld devices, m-commerce is becoming a promising research area. Personalization is especially important to the success of m-commerce. This paper proposes a novel collaborative filtering-based framework for personalized services in m-commerce. The framework extends our previous work by using Online Analytical Processing (OLAP) to represent the relations among user, content and context information, and adopting a multi-dimensional collaborative filtering model to perform inference. It provides a powerful and well-founded mechanism to personalization for m-commerce. We implemented it in an existing m-commerce platform, and experimental results demonstrate its feasibility and correctness.

Categories and Subject Descriptors

H.2.8 [**Database Applications**]: Data mining; H.3.5 [**Online Information Services**]: Web-based services.

General Terms

Algorithms, Experimentation, Human Factors.

Keywords

Personalization, collaborative filtering, m-commerce.

1. INTRODUCTION

With the rapid growth of wireless technologies and handheld devices, mobile commerce (m-commerce) is becoming a promising research area [1]. It is defined as the transactions of commodities, services, or information over the Internet through the use of mobile handheld devices. However, due to the inherent limitations of mobile devices and wireless network, a key factor for effective m-commerce is to deliver relevant information to the right people at the right time in the right way. Hence, personalization is especially important to the success of m-commerce.

Providing personalized services is about a process of matching users and merchants based on their profiles and preferences in conjunction with a changing environment constituting several context factors such as time, location and weather. In previous work, we have identified that the matching process requires effective representations of the information (including user, content and context) relationships and the inferring abilities based on the representations [2].

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Based on the excellent framework of m-commerce in [1] and the technique of multi-dimensional collaborative filtering in e-commerce [3], we propose a novel collaborative filtering-based framework for personalized services in m-commerce, which develops and enriches our previous work [2]. The basic idea is to first identify the nearest neighbors of an active mobile user by analyzing the similarity relations between the user and the history mobile users under some specific context information, and then perform personalized services based on the similar neighbors found above. Within this framework, OLAP is used to represent the relations among user, content and context information, and a multi-dimensional collaborative filtering model is adopted to perform inference. The framework can take full advantages of the multi-dimensional representation ability of OLAP and the function of collaborative filtering.

2. COLLABORATIVE FILTERING-BASED FRAMEWORK

Figure 1 shows the flow chart of the proposed framework which consists of three components. They are, (1) to collect user, content and context information; (2) to represent the multi-dimensional information by OLAP; (3) to perform inference via collaborative filtering. We introduce them in the following sections.

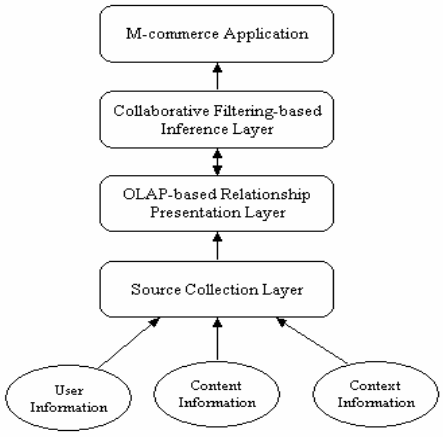

Figure 1: Flow chart of the proposed framework

2.1 Source Collection Layer and Relationship Presentation Layer

Survey technique is employed to gather the user information such as demographics (income range, ethnicity, work experience, etc.) and preferences. Context information can be obtained as follows: mobile user's location can be obtained through the PDA-embedded GPS module (outdoor) or mobile positioning system

(indoor); the time is provided by the portable device; the weather is obtained from the website of the online weather services; and user's current activities can be identified either from his/her schedules, or by mining patterns from his/her historical data. Content information is mainly uploaded by merchants through web-based merchant interfaces or collected by mobile agents from merchants' websites.

Inspired by the idea of the paper [3], we redefine the recommendation space of m-commerce by OLAP as follows, where the information mentioned above is considered.

Definition1 Recommendation Space: Recommendation space, consisting of user, content items, context (Location, Time, Weather, Activity) is represented as: $User \times Item \times Location \times Time \times Weather \times Activity$.

Accordingly, the ratings on the recommendation space are stored in a multidimensional cube.

2.2 Collaborative Filtering based Inference Layer

The multi-dimensional recommendation achieves a great success in e-commerce [3]. Encouraged by this achievement, we perform inference by the technique of the multi-dimensional recommendation for m-commerce. The inference process can be summarized as follows:

Step1: For an active mobile user, identify his/her context information;

Step2: Based on the context information, and OLAP-based multidimensional recommendation space, perform two relational operations: selection followed by projection, which obtains a two-dimensional recommendation representation;

Step3: This step involves two components, firstly, based on the produced two dimensional representation space $User \times Item$, to find active user's nearest neighborhoods according to some similarity metric; secondly, to perform top-N recommendations based on the rating information of the found neighborhood, namely, scans through their rating items and calculates the frequency count for the restaurant items, then, sorts the items according to the count, and finally, produces the top-N items list, where the items are most frequently rated by the neighbors and have not yet been rated by the active user.

3. EXPERIMENTAL RESULT

We implement the proposed framework in an existing m-commerce platform of food industry to provide Top-N recommendation, and compare its recommendation quality against that of traditional collaborative filtering. The traditional collaborative filtering represents the recommendation space by a two dimensional user-item matrix and does not consider context information. We use cosine-based function as the similarity metric and $N = 5$ as the maximum number of items, which will be recommended by our new method.

In our experiment, we test different methods on the data set, which comes from user's rating data stored in Data Service Layer of the m-commerce platform. The data collection describes users' preferences on various restaurants under different context conditions. We randomly choose 200 users and 30 restaurants items. The data set is divided into 80% training set and 20% test set.

The quality of recommendation is measured by "precision", which is widely used in information retrieval area. The definition is given as follows [4]:

$$\Pr ecision = \frac{size\ of\ hit\ set}{size\ of\ Top-N\ set}$$

Based on the metric, we compute the average precisions on test set. The comparison result of the proposed framework and traditional collaborative filtering method (without considering context information) is shown in Figure 2.

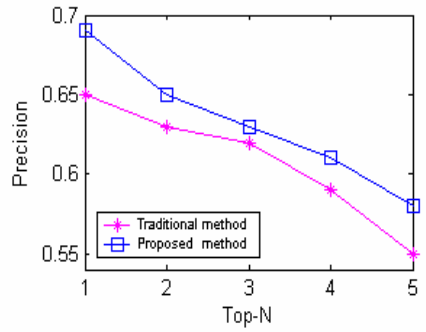

Figure 2: Average precision comparisons of two methods

From the results, we can find that the precision of our framework is higher than that of traditional collaborative filtering method. The results show that since our framework identifies the relations among user, content and context information efficiently, so the recommendation quality is improved.

4. CONCLUSIONS and FUTURE WORK

In this paper, we presented and evaluated the novel collaborative filtering-based framework for m-commerce applications, which is based on OLAP and the multi-dimensional collaborative filtering. Experimental results show that our framework can produce more accurate personalized services for m-commerce. Building more effective models to explore latent relations among neighbors is still difficult and remains the subject of ongoing research.

5. REFERENCES

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