

# Analysis and Design of E-Supermarket Shopping Recommender System

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## ABSTRACT

In this paper we study the application of recommender systems to E-supermarket. The authors analyze personalized requirement for customer in E-supermarket, and design the model of E-supermarket shopping recommender system. A dynamic hybrid recommendation method is presented.

## Categories and Subject Descriptors

D.3.3 [Information System]: E-Commerce, Recommender System, Business Intelligence

## General Terms

Algorithms, Management, Design, Theory,

## Keywords

Recommender system; CRM; E-supermarket; E-commerce

## 1. INTRODUCTION

As the World Wide Web becomes increasingly important as an information source and a place to conduct commerce, Web surfers face the daunting challenge on how to sift through a morass of information to get to the needed one. One solution to this information overload problem is the use of recommender systems [1, 2, 3]. Recommender systems are changing from novelties used by a few e-commerce sites to serious business tools that are re-shaping the world of e-commerce. Many of the largest commerce Web sites are already using recommender systems to help their customers find products to purchase.

Personalization is one of the elements that may well improve the interaction between people and computers and offer possibilities for establishing long-term customer relations. Now more than ever, the promise of electronic commerce and online shopping will depend to a great extent upon the interface and how people interact with the computer [3]: the online shopping experience. This feature is especially important for sites that offer a large spectrum of products and services to their customers, as is the case for grocery retail sites. In this paper, we study the application of recommendation systems for electronic supermarket shopping according to the peculiar

characteristics and requirements of its environment.

In the remainder of this document, more specifically in section 2 we review recommender systems and their underlying technologies. Section 3 discusses background and requirements for recommender system in e-supermarket. Section four describes prototype of e-supermarket shopping recommender system. Section 5 studies hybrid recommendation method. Finally, section six concludes with some general thoughts and suggestions regarding further research and development in this area.

## 2. RECOMMENDER SYSTEMS IN E-COMMERCE

Recommender systems are already used by many e-commerce sites under various formats, interfaces and underlying technologies [2, 3, 8, 9]. A lot of works are found. For example, [4] designed a large-scale agent-oriented information system that recommends relevant product documents to users. An extension of collaborative filtering algorithms is presented and applied to a real world retail transaction dataset. The new method deliver superior results in terms of predictive accuracy. But there is little literature to study how to make personalized recommendation based on multi-level product structure in E-supermarket. [5,6,7,8] showed traditional collaborative filtering is not suit to multi-interests recommendation where products comes from completely different product classes and presented hybrid collaborative filtering by combing collaborative filtering based on user and collaborative filtering based on item.

## 3. SYSTEM ANALYSIS

### 3.1 System Environment

The most characteristic of e-supermarket shopping recommender system is that the number of product class amount and the number of level of class are very big, and relation between products is very complex. In detail, there are following characteristic in e-supermarket: ① there are many product classes and products. ② there exist semantics problem of product. ③ Level of product level is complex.

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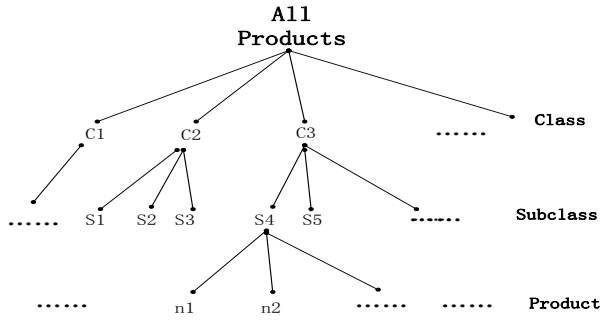


Figure 1: Level Structure of Product

### 3.2 System Requirement

(1) Requirement for customer: For customer, the system should help customer in selecting the commodity by providing personalized product information for customer.

(2) Requirement for Enterprise: Recommender system can not only simulate the seller and sale the product instead of the seller, but also support other selling activity, such as, customer behavior analysis, supporting advertisement and selling analysis, even fixing price, and so on.

## 4. SYSTEM DESIGN

E-Supermarket Shopping Recommender System (ESSRS) shown in figure 2 is a three-tiers structure, consisting of Browser, Web Server and Database Server. Web Server includes WWW Server and application server.

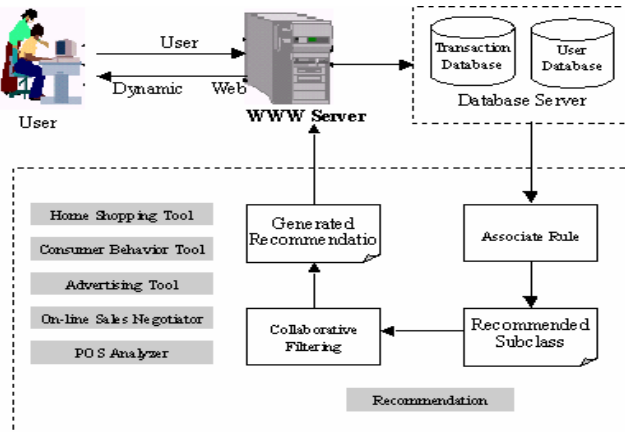


Figure 2: Framework of E-supermarket Shopping Recommender System

Application server is the most key part in e-supermarket shopping recommendation system. Database server includes transaction database and customer database. The former records detail history buying information. The later record customer's basic information. Application server is the most key part in e-supermarket shopping recommendation system. Except for recommendation module in application server, there are other components used to aid selling, for example: Home Shopping Tool, Consumer Behavior Tool, Advertising Tool, POS (Point Of Sales) Analyzer, On-line Sales Negotiator, and so on.

## 5. RECOMMENDATION METHOD

For e-supermarket shopping recommender system, what most important and key is recommendation module which decide the recommendation accuracy. So designing of recommendation method became a key step in designing e-supermarket shopping recommender system.

In general, there are two factor to be considered in selecting and designing of recommendation method: the first one is speed of recommendation, which is very important especially for on-line recommendation; the second is recommendation among all commodity classes and subclasses, which requires the balance of recommendation between same class/class and different class/subclass.

According to the above two factors, considering the background of the e-supermarket, we design a hybrid recommendation method by combining collaborative filtering and association rule. The hybrid recommendation method can be divided into two steps: the first step generate recommended subclass by applying association rule based on the subclass; the second step generate item recommendation by using collaborative filtering for all commodity of the recommended subclass.

The whole recommendation consists of two processes:

Process 1, using recommendation based on association rule to select subclass. The main task in this process is to find subclass of products in which customer will be interested by association rule. Different from additional method, in our method, association rule be done in subclass level.

Be supposed that  $T$  interesting subclasses be got by association rule,

$$S_{RS_1}, S_{RS_2}, \dots, S_{RS_i}, \dots, S_{RS_T}.$$

Denoted

$RS = \{S_{RS_1}, S_{RS_2}, \dots, S_{RS_T}\}$  as recommended subclass set;

$N(S_{RS_i})$  as product set which is affiliated with subclass  $S_{RS_i}$ ;

$N(RS) = \bigcup_{i=1}^T N(S_{RS_i})$  as product set which is affiliated with all recommended subclasses;

Process 2, Collaborative filtering recommendation based on recommendation subclass to find interested product:

In detail, there are two methods that were produce recommended products.

(1) Collaborative recommendation is done in product set

$$N(RS) = \bigcup_{i=1}^T N(S_{RS_i}), \text{ as shown in table 1:}$$

**Table 1 Collaborative recommendation in N(RS)**

Subclass	$S_{RS_1}$			$S_{RS_2}$			...	$S_{RS_T}$		
Product	$I_{11}$	...	$I_{1Q}$	$I_{21}$	...	$I_{2Q}$	...	$I_{T1}$	...	$I_{TQ}$
User 1							...			
User 2							...			
...							...			
User M							...			

(2) First, Collaborative recommendation is done in all products affiliated with certain recommended subclass respectively, such

as for  $S_{RS_i} \in RS$ , we can get recommended products for  $S_{RS_i}$ ,  $I_i = \{I_{i1}, I_{i2}, \dots, I_{iQ}\}$ .

Finally, we can produce recommended products according following two tactics:

(1) Averaging subclass recommendation : Rank all  $P(I_{ij})$  ( $t=1,2,\dots,T, j=1,2,\dots,Q$ ), select top N product as recommendation products.

(2) Weighting subclass recommendation: Considering different interest in different subclass for different user, we can weight predicted value of all recommended products,  $P(I_{ij})$  ( $t=1,2,\dots,T, j=1,2,\dots,Q$ ) by  $w(S_{RS_i})$

which can be selling amount in subclass  $S_{RS_i}$ , or can be confidence of association rule. So we can compute  $F_{ij} = w(S_{RS_i})P(I_{ij})$ , and select top N product as recommended products according to value  $F_{ij}$  ( $t=1,2,\dots,T, j=1,2,\dots,Q$ ).

## 6. CONCLUSION

In this paper we study the application of recommender systems to e-supermarket, focusing on the peculiar characteristics and requirements of E-supermarket. The authors analyze personalized requirement for customer in E-supermarket, and design the model of E-supermarket shopping recommender system. At the same time, a dynamic hybrid recommendation method for E-Supermarket shopping recommender system is presented by combining association rule based on sub-class and

collaborative filtering based on recommended sub-classes products, which eliminates the problems produced when the two techniques applied solely. The hybrid recommendation method, not only solve the demerits that association rule be not suit to the same class product recommendation but also decrease that limit that collaborative filtering be not suit to different class product recommendation. In the future, recommender system model in e-supermarket presented need be used and enhanced in practice.

## 7. REFERENCES

- [1] Resnick and Varian. Recommender systems. Communications of the ACM, 40(3):56-C58, 1997.
- [2] Schafer, J. B., Konstan, J. and Riedl, J.: 1999, 'Recommender Systems in E-Commerce'. In: EC '99: Proceedings of the First ACM Conference on Electronic Commerce, Denver, CO, pp. 158-166.
- [3] Pazzani, M. J.: 1999, 'A Framework for Collaborative, Content-Based and Demographic Filtering'. Artificial Intelligence Review, 13 (5/6), 393-408.
- [4] Andreas Milda,, Thomas Reutterer, An improved collaborative filtering approach for prediction cross-category purchases based on binary market basket data, Journal of Retailing and Consumer Services, 10 (2003) 123 - 133
- [5] YU Li, LIU Lu, LI Xuefeng, A Hybrid Collaborative Filtering Method for Multiple-interests and Multiple-content Recommendation in E-Commerce, Expert System with Application, Jan. 2005, Vol.28 P67-P77
- [6] YU Li, LIU Lu, Personalized Recommendation in E-Commerce and its Application in China, The Seventh International Conference on Industrial Management, Oct. 2004, Japan
- [7] YU Li, LIU Lu, LI Xuefeng, (2004) Study on Personalized Recommendation Algorithm for User's Multiple Interests, Vol.10 No.12, P1610-P1615 (Chinese)
- [8] YU Li, LIU Lu, Collaborative Filtering Algorithm Based on Mutual Information, The Eighth Pacific Asia Conference on Information System, Aug. 2004, Shanghai, China, P274-P287
- [9] YU Li, LIU Lu, Matrix view of the smallest association rule set based on largest frequent item-set, Computer Engineering and Application, No.23, 2003 (Chinese)
- [10] Andreas Mild, Martin Natter, A critical view on recommendation systems, Working Paper Series ,Vienna University of Economics and Business Administration, Austria, <http://www.wu-wien.ac.at/am>