Solutions for Problems of Existing E-Commerce Recommendation System

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Abstract-- **With the development of E-Commerce, it's harder and harder for consumers to find the product they want, and the recommendation systems are applied more and more widely. A recommendation system includes user model, the recommended model and recommendation algorithm. The improvement considered in this paper mainly refer to the recommendation algorithm. Limited resource, data valid time and cold start problems are not well considered in existing E-Commerce recommendation system. According to the problems described above, a algorithm based on limited resource and a solution to cold start problem are proposed.**

I. INTRODUCTION

With the popularization of the Internet and the development of E-Commerce, the structure of E-Commerce system became more and more complex. This situation made it hard for customers to find the products and services they want effectively[1].

E-commerce recommendation is to take advantage of E-Commerce site to provide information and suggestions, to help consumers make purchasing decisions[2]. Although the E-Commerce recommendation system has been successful, it faces challenges with the development of E-Commerce. Nowadays, most popular E-Commerce website, such as Amazon, adopt hybrid algorithm based on item-based recommended algorithm. Those recommender system are able to give out some recommendations for customer, but, from the view of consumers, there are still some problems which are suspected to be solved.

Compare to existing E-Commerce recommendation system, following factors should be taken into account:
1) Limited resource. For instance, personal recommendation for limited product with special lowest price in special offer period. Those kinds of products should be recommended with priority, so that customers can buy with pleasure.
2) Data valid time. Those records which were recorded long time ago are not allowed to be used for recommendation, because much early records are not accurate anymore.
3) Cold start. It's a problem for customer who first time

visit the E-Commerce website which are not well solved in existing E-Commerce recommendation system.

An effective E-Commerce recommendation system can give out effective recommendations for customers which can be approved by customers as far as possible. Customers can get benefits, at the same time, the trading volume can be enhanced[3].

II. LIMITED RESOURCE TABLE

High-frequency special sale events enhance the attention of customers and trading volume. If the products with special price can be recommended to specific customers properly, the possibility of trading will be enhanced.

Special-offer products have characteristics of lower price and limited amount. So, it's better to record those special-offer products in a table in database in advance. Usually, the record list of special-offer products should be recorded automatically by recommendation system when seller modify the price. In particular, in the special sale period, the record of special-offer products can be given out by official platform.

In addition, the purchasing probability of limited special-offer product i (p_i) is a critical data for recommendation system. Those products with extremely low probability, which is meaningless, are not expected to be recommended. The purchasing probability of product i (p_i) can be defined as follow: $p_i = \frac{s_i}{a_i}$

Among the formula, a_i is the number of attention of product i, s_i is the stock of product i.

The table of special-sale products must include unique identification, stock, purchasing probability of each product. According to the expression above, the table of special-sale products is designed as follow table:

TABLE I
Special-offer Product Properties

Column	Type	NULL/NOT	Description
SOP-ID	VARCHAR(10)	NOT	Identifier of product
SOP-Stock	NUMBER(5)	NOT	Stock of product
SOP-Price	FLOAT(6)	NOT	Price of product
Probability	DOUBLE(3)	NOT	Purchasing probability [0,1]

The products recorded in the table which fit customer's interests should be recommended with priority.

III. CONTENT-BASED ALGORITHM BASED ON LIMITED RESOURCE

Content-based algorithm was the earliest classic recommendation algorithm, the idea of it is that give out the objects with highest similarity in content as result, according to the objects user interested in[4]. The algorithm mainly contains three steps: 1) Item Representation; 2) Profile Learning; 3) Recommendation Generation.

Content-based Recommendation Algorithm is based on products that customer has been searched, seen and purchased. So, an important thing should be paid attention to is the time of those products were searched, seen and purchased. If those action happened more than three months ago, those products would not be expected to be used to be a part of content. Therefore, data valid time should be controlled well. Data valid time $T = t_{now} - t_0$ (the time between recommendation time and data recorded time) should not be more than 90 days.

When the vector model of product is abstracted, a conditional statement can be added in order to control data valid time. When the degree of preference ω_i is calculated, if product i belongs to special-offer (limited resource) list, a coefficient should be multiplied by ω_i. Based on limited resource, taking data valid time into account, an improved Content-based algorithm can be described as follow:

Limited-Resource Content-based Algorithm
1: for each $p_i \in p_u$ 2:   if $T \leq 90$
3:      get the vector of p_i
4: for each $p_i \in p_{all}$
5:    $\omega_i = Riccho(p_i)$
6:    if $p_i \in p_r$
7:      $\omega_i = (1 + \alpha)\omega_i$
8: GetTop10( );

Fig 1 Limited-Resource Content-based Algorithm

p_u is the set of products which user has been paid attention to. p_{all} is the set of all the products which are available to be recommended. p_r is the set of products in special-offer records list.

IV. COLD START

Cold start, as a special case of sparse problem[5], is caused by lack of new users' historical information. There are some basic solutions have been already proposed, such as random algorithm, average algorithm, however, the personalization is sacrificed[6].

So, some basic information of user should be taken into account, such as the location, registration time. Users from same place, with similar registration time, are very likely to have similar purchasing needs. If recommendations can be given out recommendation system, according to similar users' purchase, it would be helpful for new user. According to description above, a solution can be proposed which mainly contains 4 steps:

1) Obtain the location of user based on GPS and get the registration time of target user.
2) Statistics users in same location who registered within 1 year and their purchasing history.
3) Calculate the trading volume of each product in the statistical results.
4) Sorted by trading volume and get top 10 products as recommendation result.

A well recommendation to new customer can enhance the trust and loyalty of new customers. So the well algorithm which can solve cold start problem has to be applied to E-Commerce websites.

V. CONCLUSION

With the development of E-Commerce, personalized recommendation has been paid more and more attention. Limited resource situation, data valid time and cold start problems have not been well considered in existing E-Commerce recommendation system. This paper proposes limited resource table method, an algorithm based on limited resource and a solution to cold start problem, which can enhance the effect of recommendation system. The solutions proposed in this paper are meaningful for E-Commerce websites and recommendation system. In the future, more and more factors will be taken into account in E-Commerce recommendation system.

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