

A Consumer Recommend Mechanism in Agent-Based E-Commerce Platform

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Abstract

With the rapid development of Internet technologies, information exchange became much easier. The Internet makes infinite charms and enormous population and also makes E-Commerce well developed. Mobile agents are mobile, personalized, autonomous, and adaptive. These qualities make mobile agents useful for the information-rich and communication-rich environment such as E-Commerce. The ways of building online shopping markets which are most used in common commerce sites have two kinds of main drawbacks: 1. Because of the different product data format in database and representation, it is difficult to exchange information between the two online markets. 2. Consumers must search and filter product information by browsing a lot of shopping sites and have to compare the product prices by themselves. 3. It's hard to accumulate consumer's loyalty. Therefore, the purpose of the paper is to extend the E-commerce platform that developed by our agent-based E-Commerce research group and build an agent-mediated consumer recommend mechanism. Followed the mechanism, agents on behalf of consumer can trade in the E-commerce platform and record the consumer preference and produce the appropriate product recommend information according to consumer's preference.

Keywords: Agent, Mobile agent, E-commerce, Recommend mechanism

1. Introduction

Due to the popularization of Internet and World Wide Web (WWW), the limitation of distance and region are broken for business

behaviors. E-Commerce can help a company or enterprise to extend its market place to unlimited region. At the same time, to let companies and enterprises can have transactions through Internet, more new techniques are developed for Internet and WWW applications. Agent technique is one of the important technologies developed to support the Internet applications. When the users are off-line, the agents are still active in the world of computer network and play the role of their users. Agent is software that assistants or represent the behaviors of users in the world of computer network. The basic properties of agents are following [1]: (1) Reactive, (2) Autonomous, (3) Object-oriented, (4) Communicative, (5) Mobile, (6) Learning, and (7) Believable.

A mobile agent is an agent, which has the capability of mobility on the world of computer network. There are some advantages of mobile agent technologies are applied on network [1]: (1) reduce the network load, (2) overcome network latency, (3) encapsulate protocols, (4) execute asynchronously and autonomously, (5) adapt dynamically, (6) robust and fault-tolerant.

The major objective of this research is to extend the E-commerce platform that developed by our agent-based E-Commerce research group. In this paper, a consumer recommend mechanism is proposed for E-Commerce platform based on agents and mobile agents. There are some issues will be researched. They include the introduction and platform of mobile agents, the recommend mechanism, ... etc. Based on this architecture of consumer recommend mechanism, the applications of E-commerce will be more effective, easier to develop, and more creating the marketing of business.

This article is organized as follows: section 2 describes the related works that include the introduction of mobile agent, the developed platform, Aglet, and some researches of recommend mechanism. Section 3 presents the system model of proposed E-commerce platform, the market place model and the consumer recommend mechanism. The establishment processes of consumer recommend mechanism are shown in section 4. The last part of this article is our conclusions and future researches.

2. Related works

2.1 Aglet

Aglets had been proposed by the Aglets team at IBM's Tokyo Research Lab[2]. Aglets are Java objects that can move from one host on the network to another. When the aglet moves, it takes along its program code as well as the states of all the objects it is carrying. A build-in security mechanism makes it safe to host untrusted aglets. The system goals of aglets are following:

- ◆ Provide an easy and comprehensive model for programming mobile agents without requiring modifications to Java VM or native code.
- ◆ Support dynamic and powerful communication that enables agents to communicate with unknown agents as well as well-know agents.
- ◆ Design a reusable and extensible architecture.
- ◆ Design a harmonious architecture with existing Web/Java technology.
- ◆ Provide security mechanisms that are comprehensive and simple enough to allow end users to trust mobile agents.

2.2 Profile

User profiling [3] is typically either knowledge-based or behavior-based. Knowledge based approaches engineer static models of users and dynamically matches users to the closest model. Questionnaires and interviews are often employed to obtain this domain knowledge. Behavior-based approaches use the users behavior itself as a model, often using machine-learning techniques to discover useful patterns of behavior. Some sort of behavioral logging is usually employed to obtain the data necessary from which to extract behavioral patterns. The typical user profiling approach for recommender systems is behavioral-based, using a binary model (two classes) to represent what users find interesting and uninteresting. Machine-learning techniques are then used to assess potential items of interest in respect to the binary

model. There are a lots of effective machine learning algorithms based on two classes.

2.3 Recommend Mechanism

Recommender systems are used for E-commerce sites to suggest products to their customers. The products can be recommended based on the top overall sellers on a site, based on the demographics of the customer, or based on an analysis of the past buying behavior of the customer as a prediction for future buying behavior. Broadly, these techniques are part of personalization on a site, because they help the site adapt itself to each customer. Recommender systems automate personalization on the Web, enabling individual personalization for each customer.

Recommender systems [4] enhance E-commerce sales in three ways:

1. **Browsers into buyers:** In generally, visitors to a Web site often look over the site without ever purchasing anything. Recommender systems can help customers find products they wish to purchase.
2. **Cross-sell:** Recommender systems improve cross-sell by suggesting additional products for the customer to purchase. If the recommends are good, the average order size should increase. For instance, a site might recommend additional products in the checkout process, based on those products already in the shopping cart.
3. **Loyalty:** Recommender systems improve loyalty by creating a value-added relationship between the site and the customer. Web stores use recommender systems to optimize learning technology, and present custom interfaces that match customer needs. Customers will repay these sites by returning to the ones that best match their needs. And if web site creates relationships between customers can also increase loyalty.

In recommend system [5], information filtering agents and collaborative filtering both attempt to alleviate information overload by identifying which items a user will find worthwhile. Information filtering (IF) focuses on the analysis of item content and the development of a personal user interest profile. Collaborative filtering (CF) focuses on identification of other users with similar tastes and the use of their opinions to recommend items. The follows describe more detail about the two technologies:

1. **Information filtering (IF)** systems require a profile of user needs or preferences. The simplest systems require the user to create this profile manually or with limited assistance. Some advanced IF systems may

build user profile from learning the user's preferences. Information filtering techniques have a central role in recommender systems. IF techniques build a profile of user preferences that is particularly valuable when a user encounters new content that has not been rated before. IF techniques also have an important property that they do not depend on having other users in the system, let alone users with similar tastes. IF techniques can be effective but they suffer certain drawbacks, including requiring a source of content information, and not providing much in the way of serendipitous discovery.

2. **Collaborative filtering (CF)** systems build a database of user opinions of available items. They use the database to find users whose opinions are similar (i.e., those that are highly correlated) and make predictions of user opinion on an item by combining the opinions of other likeminded individuals. More recently, a number of systems have begun to use observational ratings; the system infers user preferences from actions rather than requiring the user to explicitly rate an item. In the past year, a wide range of web sites have begun to use CF recommends in a diverse set of domains including books, grocery products, art, entertainment, and information. Collaborative filtering techniques can be an important part of a recommender system. One key advantage of CF is that it does not consider the content of the items being. For a CF system to work well; several users must evaluate each item; even then, new items cannot be recommended until some users have taken the time to evaluate them. These limitations often referred to as the *sparsity* and *cold-start problems* [6].

3. The architecture of recommend mechanism

3.1 The Proposed E-Commerce Platform

The proposed E-commerce platform are divided into three layers:

1. **Mobile Agent Platform:** This layer is the most bottom layer of the architecture for e-marketplace. This layer is the mobile agent platform [7] that has developed by several institutes and organizations in recent years, such as Zeus, Jade and IBM Aglet. After comparing several factors such as flexibility and support, we decided to adopt IBM Aglet

to be our mobile agent platform, which supports the creation, clone, deletion and migration of mobile agent.

2. **Interface:** Interface layer connects mobile agent platform layer and e-commerce platform layer. This layer will include some special components that are developed for e-commerce especially. These components provide necessary services such as connecting user GUI and IBM Aglet, database connection, and security mechanisms for e-commerce.
3. **E-Commerce Platform:** E-commerce platform is the most top layer of the architecture for e-marketplace. With the support of interface layer and mobile agent platform layer, programmer can design various applications for e-commerce, for example, mobile agents for buyer and seller, recommend system for consumer.

3.2 The system architecture of E-Commerce platform

There are three servers: (1)Coordinator Server, (2)Marketplace, (3)Buyer Agent Server, and (4)Seller Server in our E-Commerce platform. Each server has several Agents and Mobile Agents. Figure 3.1 shows the E-commerce architecture. In the follow section, descriptions of servers, Agents and Mobile Agents will be presented.

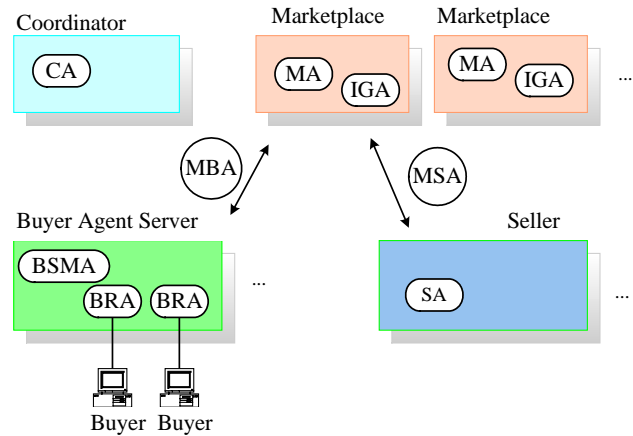


Figure 3.1. The architecture of proposed E-Commerce platform

1. **Coordinator Server:** There is a Coordinator Agent (CA) in Coordinator Server. The CA is static in Coordinator Server and manages an E-Commerce (EC) domain. CA has several abilities:
 - Initial an EC domain,
 - Monitors Marketplaces, Buyer Agent Servers and Seller Agents,

- Manages Marketplaces, Buyer Agent Servers and Seller Agents,
 - Provides the functions of register and query, and
 - Cooperates with other CA.
2. **Marketplace:** Marketplace [8] is a place that lets the Mobile Agent of the Buyer and the Mobile Agent of the Seller trade with each other. And provide kinds of trading services such as: information query, negotiations, and auctions. There are two kinds of static Agents and two kinds of Mobile Agent in the Marketplace:
- **Management Agent (MA):** MA is a static Agent in the Marketplace. It has two abilities: 1) manages the register of Mobile Agents that enter the Marketplace, 2) manages the Agents and Mobile Agents that are in the Marketplace.
 - **Information Gather Agent (IGA):** IGA is a static Agent in the Marketplace. IGA will gather the many kinds of data in the Marketplace. The data may be the record of transaction, the information of the production...etc.
 - **Mobile Buyer Agent (MBA):** MBA stands for the buyer, moves from Marketplace to Marketplace and trades with Mobile Seller Agent.
 - **Mobile Seller Agent (MSA):** MSA stands for the seller, moves from Marketplace to Marketplace and trades with MBA.
3. **Buyer Agent Server:** Buyer Agent Server equals to the proposed consumer recommend mechanism. In this paper, the main point is to build a recommend mechanism. A consumer recommend mechanism stands for servicing a consumer community. A consumer recommend mechanism have to provide the executable system and the storage of saving consumer personal information. Consumers can connect to the consumer recommend mechanism through browser with PC or Notebook. And the consumer recommend mechanism can automatically serve consumer with assigned tasks even if consumer is offline. And the system architecture of recommend mechanism will be described in next section.
4. **Seller Server:** Seller Server stands for the seller and merchandise provider. The seller server's function contains integrating and cataloging merchandise. The further more, in this E-commerce platform, Seller Server can

create seller agent to provide selling service to the marketplaces in the E-commerce platform.

3.3 Recommend mechanism

The main functions of proposed recommend mechanism include:

1. **Assistance of Query and transaction:** Differs from the traditional bargains, the recommend mechanism use agent and mobile agent to help consumer automatically trading. In this recommend mechanism, each buyer recommend agent (BRA) stands for a consumer to provide one to one consuming service.
2. **Generalizing consumer recommend information:** Recommend mechanism can record the consumer's behavior (ex: merchandise query, buy, negotiation, and auction) by BRA, and update consumer profile. And find some other consumer favorites goods whose interest is closest the consumer from User Database (UserDB) with the newer profile. According to filtering the information and the goods querying results, recommend mechanism can provide consumer the appropriate recommend information.

Figure 3.2 shows the architecture of recommend mechanism. And the follows describe complete actor of the proposed recommend mechanism:

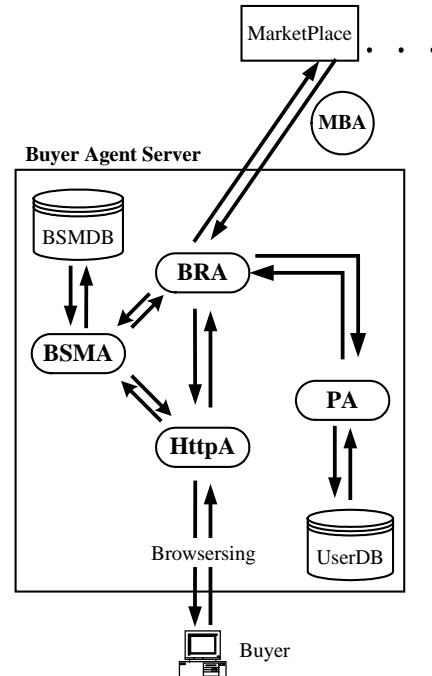


Figure 3.2. The architecture of recommend mechanism

1. **Buyer Server Management Agent (BSMA):** BSMA is the manager of Buyer Agent Server. BSMA has several abilities:

- **Providing information of the E-Commerce:** The BSMA will get the information of newer marketplace or seller server from Coordinator Server. And these records will be kept in Buyer Server Management Database (BSMDB).
- **User Register and login:** When user register or login, the Http Agent (HttpA) will translate the message to BSMA, when consumer login successful, BSMA will create a Buyer Recommend Agent (BRA) works for that consumer.
- **The management of agent and mobile agent:** In the recommend mechanism, BSMA have to keep monitor and record the whole agents and mobile agent in recommend mechanism. Even though the BRA create Mobile Buyer Agent (MBA) and MBA migrate to marketplace to buy or query merchandise information or auction information.

2. **Http Agent (HttpA):** HttpA provides the Web interface, let users can use the browser to use all service of Buyer Agent Server. HttpA can translate the aglet message between Web interface and agent or mobile agent.

3. **Profile Agent (PA):** Each recommend mechanism contains only one PA. PA stands for creating or updating user profile. When consumer query, buy or join auction PA will generate the newer consumer profile to record consumer behavior.

4. **Buyer Recommend Agent (BRA):** A BRA stands for online consumer. The main functions of BRA are:

- **Loading Profile:** When consumer login recommend mechanism, BSMA will create a BRA for the consumer. And BRA will request PA to get the current user profile.
- **Providing the assistance of merchandise query and the other bargain functions.** BRA will create MBA to marketplace with assigned tasks such as merchandise query, negotiation, buy or auction.
- **Creating recommend information:** After MBA visited the assigned marketplace and return merchandise information back to BRA. According

to the newest consumer profile BRA will send request to analyze the UserDB to find the other similar interest consumer. And then BRA will filter the merchandise information and the similar interest consumer's profile, and generalize the recommend information.

5. **Mobile Buyer Agent (MBA):** MBA created by BRA. When consumer decides to query, buy or auction BRA will create MBA and assign specified tasks. MBA will migrate to marketplaces in E-Commerce and represent consumer to complete the assigned task.
6. **User Database (UserDB):** UserDB records the consumer user profile and consumer transaction records.
7. **Buyer Server Management Database (BSMDB):** BSMDB records the E-commerce platform's marketplaces; sell server and coordinator server information. The on-line BRA information and the corresponding MBA that migrate to marketplace will also be recorded in BSMDB.

4. The Recommend Mechanism

The follows shows the principles of recommend mechanism, the creation of recommend mechanism, the workflow of recommend mechanism and the way of generating recommend information.

4.1 The principles of recommend mechanism

1. When consumer registers the recommend mechanism don't create BRA. Until consumer login the system, BRA will be created to serve specified consumer and load the consumer's profile to BRA. When consumer logout the BRA will terminate.
2. When consumer want query merchandise or bargain merchandise, BRA will create MBRA and assign tasks and then dispatch MBRA to marketplace. At this time, BRA will note BSMA to keep the MBA's information. MBA must authenticate itself to BSMA, when MBA finish its work and migrate back to the recommend mechanism.
3. When BRA dispatch MBA to marketplace BSMA will execute the "*Aglet.deactive()*" to BRA which can store the BRA to recommend mechanism storage. Until MBA migrate back to the recommend mechanism and pass the authentication, BSMA will execute "*Aglet.active()*" to load the BRA to memory to online.
4. BRA will records the consumer information of merchandise query, bargain and auction and

these data will be sent to PA and update the consumer's profile.

5. The MBA created by the recommend mechanism will use the same message type. When MBA passes the authentication MBA will be able to migrate to marketplace to do its task.
6. The coordination of functional agents in recommend mechanism is through the message passing.

4.2 The creation of Recommend Mechanism

The creation of proposed E-Commerce platform is described in [9]. Figure 4.1 shows the creation of recommend mechanism:

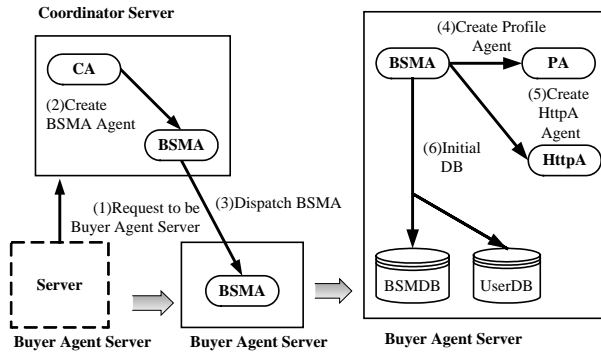


Figure 4.1 the creation of recommend mechanism

4.3 The Workflow of Recommend Mechanism

In this section shows the workflow of add user, user login, merchandise query, bargain and auction.

4.3.1 The Workflow of Consumer Login

The proposed E-Commerce platform is public access, user want to be legal user is just finish the registration form and reply the authentication mail.

In order to save the system loading, the recommend mechanism will create BRA to serve consumer when he login successful without create BRA when the user pass the registration. The follows and figure 4.2 describe the consumer login workflow:

1. Consumer input ID and password to login. (Fig 4.2-1) HttpA translate data to Aglet message and send to BSMA. (Fig 4.2-2)
2. BSMA check BSMDB to match the password and return.
 - Correct: login success. (Fig 4.2-5)
 - Incorrect: login failed and return error message. (Fig 4.2-4,8,14)
3. BSMA check BSMDB to find if the consumer corresponding BRA exists and its state:
 - Activate: The consumer may just disconnected and re-login and BRA is just finished the assigned task. Then execute Fig 4.2-9.

- De-active: The consumer may just disconnected and re-login, and BRA is waiting for MBA migrating back from marketplace. If consumer wants to discard MBA to finish its task, the BSMA sets BRA to "Activate". And then execute Fig 4.2-9. Else BRA will wait for MBA finished its job then execute Fig 4.2-9.
- It means the assigned task is finished, if BRA un-exist, then execute Fig 4.2-7.

4. BSMA creates a BRA (Fig 4.2-7), and store the BRA's information to BSMDB (Fig 4.2-5,6) then execute Fig 4.3-8.
5. BRA request PA to load the last-updated consumer profile. (Fig 4.2-9)
6. PA query UserDB to get the newest consumer profile (Fig 4.2-10,11), and return the information to BRA (Fig 4.2-12).
7. BRA sent back the login successful message to HttpA, and HttpA translate the message into web message and send to consumer PC. (Fig 4.2-13,14)

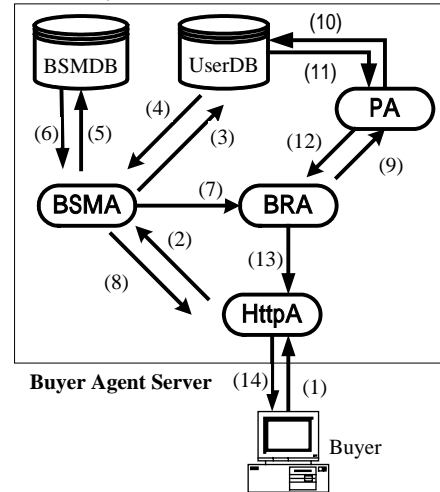


Figure 4.2 the workflow of user login

4.3.2 The Workflow of Merchandise Query

After consumer query merchandise information, the recommend mechanism will find the similar interest user from UserDB, and get the user's merchandise preference. Compare the queried merchandise information and the similar user's merchandise preference; the appropriate recommend information will be generated. The follows and figure 4.3 show the workflow of merchandise query:

1. User input the query string (the name or keyword of query merchandise) on web interface and submits. (Fig 4.3-1) HttpA translate the query string to Aglet message and send to BRA. (Fig 4.3-2)

- BRA request BSMA to get the accessible marketplaces. (Fig 4.3-3,4,5,6)
- Before BRA create and dispatch MBA to query, the query string will be sent to PA to update consumer profile and store in UserDB, and then the newest profile will be sent back to BRA. (Fig 4.3-7,8,9,10)
- BRA creates MBA and dispatch to the marketplace. (Fig 4.3-11) BRA will send AgletID of MBA to BSMDB to record the information. (Fig 4.3-3,4,5,6)

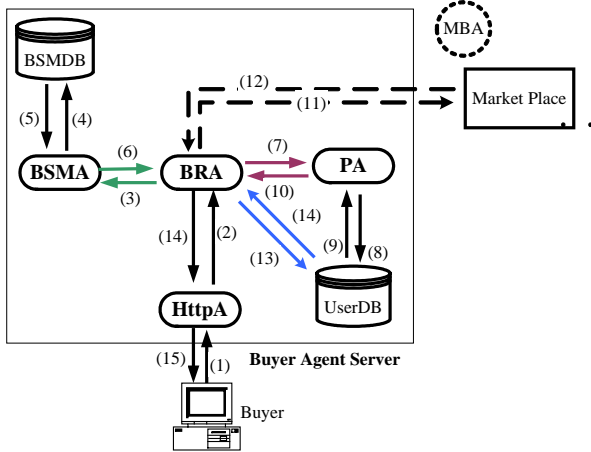


Figure 4.3 the workflow of merchandise query
4.3.3 The Workflow of Buy or Auction

When consumer decides to buy or auction merchandise the recommend mechanism will also keep the merchandise information to update user profile. The follows and figure 4.4 show the workflow of buy or auction:

- Consumer decides to buy some merchandise or join some auction in specified marketplace. (Fig 4.4-1) HttpA translate the string to Aglet message and send to BRA. (Fig 4.4-2)
- BRA request BSMA to check if the marketplace exists. (Fig 4.4-3,4,5,6)
 - Un-exist marketplace: Return error message to user. (Fig 4.4-6,13,14)
 - Exist: Execute Fig 4.4-7
- BRA creates MBA and dispatch MBA to specified marketplace (Fig 4.4-7) and notes BSMA to record the AgentID of MBA to BSMDB. (Fig 4.4-3,4,5,6)
- After MBA finish the assigned task and migrate back recommend mechanism, MBA must verify itself to BSMA and then migrate back to BRA. At least MBA translate the transaction record to BRA, BRA terminate the MBA.
- BRA translate the transaction record to PA, PA generate the new consumer profile and store to UserDB. At least PA sends the newest

- profile back to BRA to keep the BRA to have the newest consumer profile. (Fig 4.4-9,10,11,12)
- HttpA get the result (Fig 4.4-13) and translate the message to web form information to client. (Fig 4.4-14)

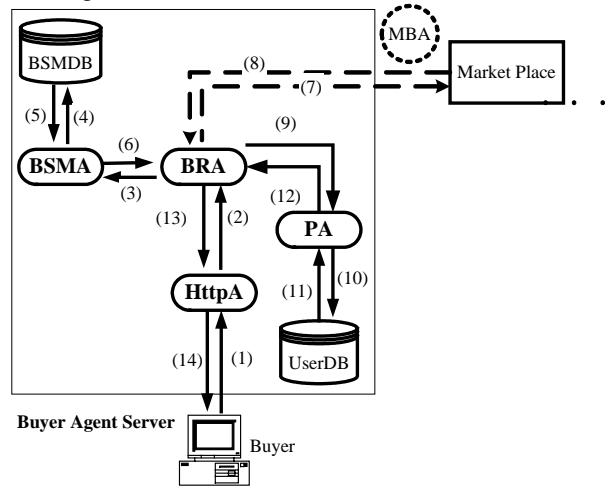


Figure 4.4 the workflow of buy or auction.
4.4 The Recommend Information Generation

The profile presentation in recommend mechanism quotes Jin-gan [10]. Fig 4.5 shows the profile presentation.

Figure 4.5 the presentation of consumer profile. The generation of recommend information is to

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Profile = <Category, Terms_of_category,
<Sub_Category, Terms_of_Sub_Category><j>i

Category: main user profile
Terms_of_Category: terms of a main category characters
Sub_Category: sub category of a main category
Terms_of_Sub_Category: terms of a sub category

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find the similar user's profile through the similarity. If Consumer X's preference merchandise item value Tx different from other consumer Y's preference merchandise item value Ty, the similarity result will be discard. The higher similarity value means that consumer X is more similar to consumer Y. And then compare the consumer Y's profile with the user queried merchandise information the recommend information is generated. The follows and figure 4.6 shows the quote similarity algorithm [10]:

$$Similarity = \frac{\sum W_x W_y}{\sqrt{\sum_{x=1}^{\#termX} W_x^2 \sum_{y=1}^{\#termY} W_y^2}}$$

W_x : weight of term T_x in user profile
 W_y : weight of term T_y in another user profile

Figure 4.6 the similarity algorithm.

5. Conclusion and Future works

5.1 Conclusion

The capabilities of proposed recommend mechanism are:

1. Each functional agent is responsible for different tasks, and cooperates to provide services in the recommend mechanism. It is flexible that we can increase or decrease the number and the kind of functional agents in the recommend if necessary.
2. We designed buyer recommend agent to present as a consumer and help consumer to transact in the marketplaces. And then the BRA can create mobile agent and dispatch it to transact in marketplaces.
3. The MBA can collect merchandise information between more than two online marketplaces in the E-Commerce platform.
4. The recommend mechanism can generate recommend information to consumers from the applied similarity algorithms.

5.2 Future works

Our recommend mechanism will improve in some directions in the future. We describe these directions below:

1. Improve the profile algorithm and presentation to generate more applicable recommend information.
2. Provide the more kinds of recommend information such as weekly hottest merchandise, and tied-sale information.
3. Increase the scope of recommend mechanism. And apply the interaction of consumer community.
4. Improve the authentication mechanism when MBA migrate back the recommend mechanism to provide safer service.

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