An Agent-Based Consumer Recommendation Mechanism

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Abstract

With the rapid development of Internet technologies, 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 common online shopping markets 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-bated consumer recommendation 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, Recommendation 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.

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 marketplace model and the consumer recommend mechanism. The establishment processes of consumer recommend mechanism will be 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 un-trusted aglets. The system goals of aglets are following:

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- 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 Recommendation 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 Recommendation 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):**
   These 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):**
   These 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 recommendation 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], 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 interface provides 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, recommender 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.

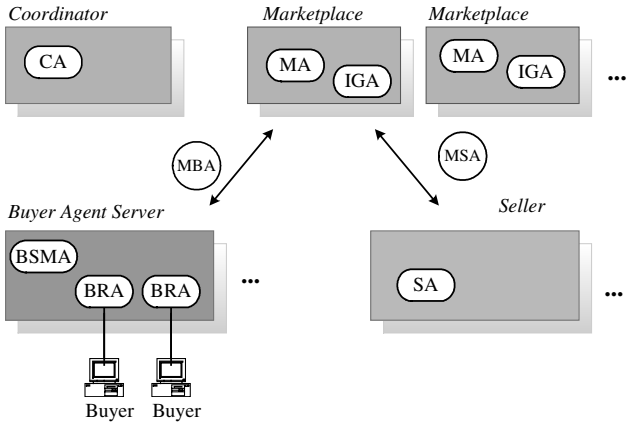

Figure 3.1. The architecture of proposed E-C platform

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.
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.
3. **Buyer Agent Server:**
   Buyer Agent Server is also the proposed consumer recommendation mechanism. In this paper, the main point is to build a recommendation mechanism. A consumer recommendation mechanism stands for servicing a consumer community and providing the executable system and providing the storage of saving consumer personal information. Consumers can connect to the consumer recommend mechanism through browser with PC or Notebook. And the consumer recommendation mechanism can automatically serve consumer with assigned tasks even if consumer is offline.
4. **Seller Server:**
   Seller Server stands for the seller and merchandise provider. The seller server's function contains integrating and cataloging merchandise.

3.3 Recommendation 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:

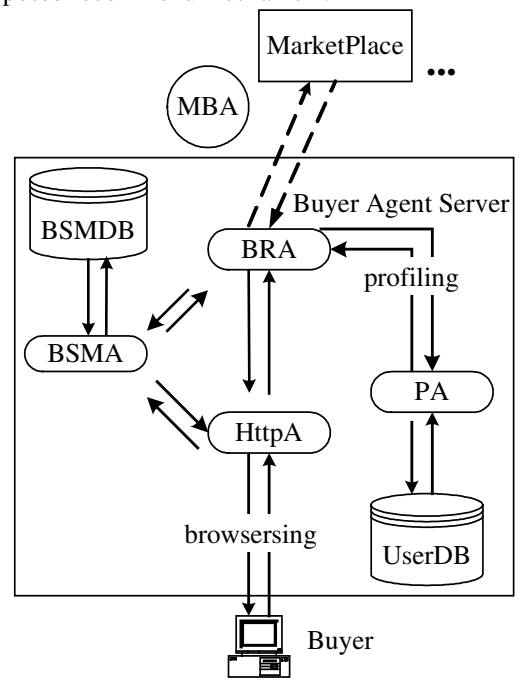

Figure 3.2. The architecture of recommendation mechanism

1. **Buyer Server Management Agent(BSMA):**
   BSMA is the manager of Buyer Agent Server. BSMA has several abilities:(1) the E-Commerce information providing. (2) user registration and login. (3) the management of agent and mobile agent.
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 recommendation 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: (1) Loading Profiles. (2) Providing the assistance of merchandise query and the other bargain functions. (3) Creating recommendation 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 Recommendation Mechanism

4.1 The principles of recommendation mechanism

1. When consumer registers the recommendation 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 recommendation mechanism.
3. When BRA dispatch MBA to marketplace BSMA will execute the "Aglet.deactive( )" to BRA which can store the BRA to recommendation mechanism storage. Until MBA migrate back to the recommendation mechanism and pass the authentication, BSMA will execute "Aglet.active( )" to load the BRA to memory.
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 recommendation 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 recommendation mechanism is through the message passing.

4.2 The Creation of Recommendation Mechanism

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

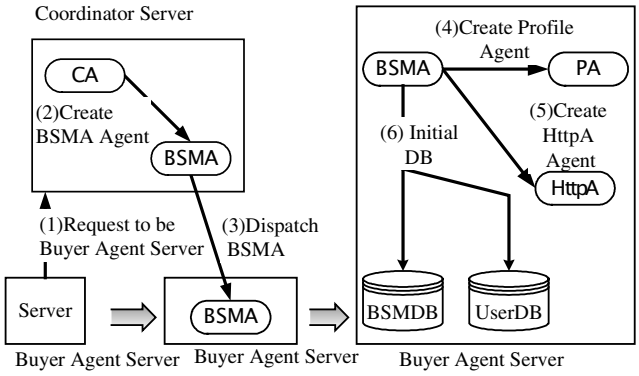

Figure 4.1 the creation of recommendation mechanism

4.3 The Workflow of Recommendation Mechanism

4.3.1 The Workflow of Merchandise Query

After consumer query merchandise information, the recommendation 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 recommendation information will be generated. The follows and figure 4.2 show the flow of query:

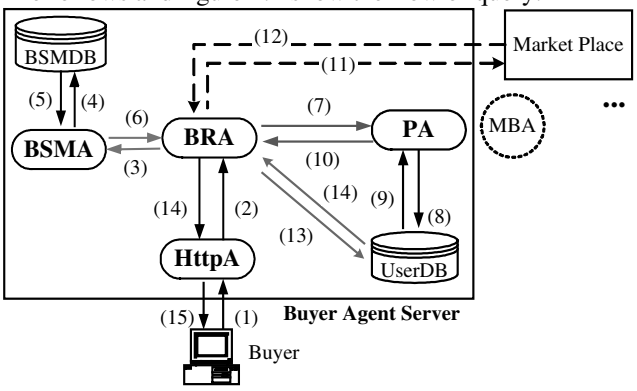

Figure 4.2 the workflow of merchandise query

4.3.2 The Workflow of Buy or Auction

When consumer decides to buy or auction merchandise the recommendation mechanism will also keep the merchandise information to update user profile. The follows and figure 4.3 show the workflow of buy or auction:

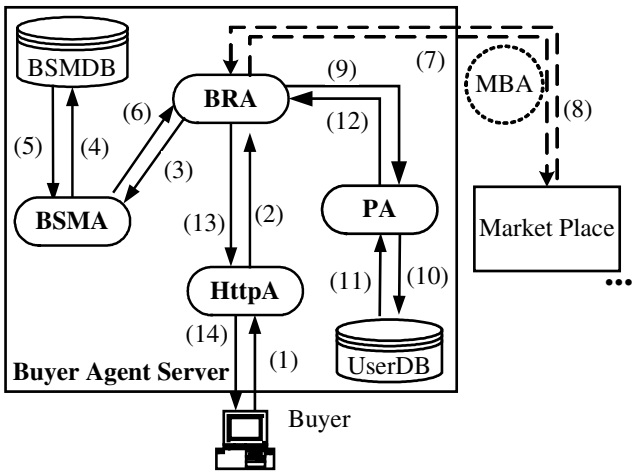

Figure 4.3 the workflow of buy or auction.

4.4 The Recommendation Information Generation

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

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*

Figure 4.4 the presentation of consumer profile.

The generation of recommendation information is to 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 recommendation information is generated. The follows and figure 4.4 shows the quote similarity algorithm [10]:

$$New\_profile\_of\_Category\_c = \sum_{i=1}^{\#term} (W_{ci} + \alpha * w_{ji} * quality\_of\_feedback)$$

W_{ci} the weight of term *i* in category c

W_{ji} the weight of term I from document j

α the learning rate

Figure 4.5 the similarity algorithm.

5. Conclusion and Future works

5.1 Conclusion

The capabilities of proposed recommendation mechanism are:

1. Each functional agent is responsible for different tasks, and cooperates to provide services in the recommendation mechanism. It is flexible that we can increase or decrease the number and the kind of functional agents in the recommendation mechanism if necessary.
2. We designed buyer recommendation 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 then two online marketplaces in the E-Commerce platform.
4. The recommendation mechanism can generate recommendation information to consumers from the applied similarity algorithms.

5.2 Future works

The proposed recommendation 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 recommendation information.
2. Provide the more kinds of recommendation information such as weekly hottest merchandise, and tied-sale information.
3. Increase the scope of recommendation mechanism. And apply the interaction of consumer community.
4. Improve the authentication mechanism when MBA migrate back the recommendation mechanism to provide safer service.

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