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Designing Intelligent Agent System for Purchase Decision Making in Retail Electronic Commerce

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For the purchase of a cheaper product on the Internet, many customers have been trying to search online shopping mall sites and visit comparison-pricing shops that compare prices and other criteria of the product. Others have been participating into online auction markets or group-buying markets. However, a lot of online shopping malls, auction markets, and group-buying markets provide the same product with different prices. Since these marketplaces have different price settlement mechanisms, it is very difficult for the customers to determine marketplace to purchase, considering different kinds of marketplaces at the same time. To overcome such limitations, decision rules and solution procedures for purchase decision making are necessary, which can cover multiple marketplaces simultaneously. For this purpose, purchase decision making in each market must be conducted to maximize customer's utility, and conflicts with other marketplaces must be resolved. Therefore, we have developed the rules and methods that can negotiate cooperatively the purchase decision making in several marketplaces, and designed an architecture of Intelligent Buyer Agent and a message structure to support the idea.

Key words : Intelligent Agent, Electronic Commerce, Multi-Agent Negotiation

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1. Introduction

Since Electronic Commerce (EC) boomed with the proliferation of the Internet, customers are suffering from the confusion due to the flood of information available. They find it difficult not only to look into too many online shopping mall sites but also to compare a variety of transaction conditions, including prices. In order to lighten such burden, the comparison-pricing shopping model has been utilized in online shopping. It compares prices and other criteria (attributes such as functions, design, manufacturers, etc.) of the product item the customer wants to buy. It searches and shows the arranged information from the merchants it can reach. Comparison shopping websites have many limitations, however. At an early stage, many merchants superior to others in

some criteria except price left those sites or would not enter into them. Recently, those sites have taken into account other functions such as free delivery cost, customer evaluation etc., but they are not complete yet. Furthermore, different marketplaces, such as online auction and group-buying markets, are operating successfully on the Internet. They have dynamic pricing mechanism compared with the shopping malls that provide the product with fixed prices. The comparison-pricing shopping mall model cannot operate in such marketplaces.

To overcome such limitations, decision rules and solution procedures for purchase decision making are necessary, which can cover multiple marketplaces simultaneously. Since the prices change dynamically in auction and group-buying markets as customers participate, the appropriate purchase decision making is necessary according to the conditions and situations of the market. Therefore, we have developed the rules and methods that can coordinate cooperatively purchase decision making in several marketplaces. For this purpose, purchase decision making in each market must be conducted to maximize customer's utility, and conflicts with other marketplaces must be resolved.

To implement such idea, the agent with the autonomy and personalization is considered the most appropriate. Therefore, we have designed an architecture of Intelligent Buyer Agent and message structure to support the idea.

This paper is organized as follows: Section 2 presents related research Section 3 shows the architecture of the Intelligent Buyer Agent; Section 4 discusses decision rules for shopping; Section 5 describes message layers, and; Section 6 outlines the solution procedure.

2. Related Works

Researches in intelligent agent show a variety of applications in Electronic Commerce. In the view of marketplaces, intelligent agents are utilized mainly for product and/or merchant selection in online shopping malls. In comparison shopping, for instance, they search the product or merchant that matches the customer's request or remove irrelevant ones from some product or merchant sets. They also show the list of the selected items along with their detailed information by sorting them according to some criteria such as price, customer's preference order, etc. PersonaLogic, Firefly(Guttman et al. 1998), and UNIK-SES(Lee et al. 1996) are some of the earliest intelligent comparison shopping agents for product brokering. BargainFinder(Wilder 1995), Jango(Guttman et al. 1998), Roboshopper(Murch & Johnson 1999), BottomDollar(Murch & Johnson 1999), FIDO(www.shopfido.com), Mx BookFinder(Murch & Johnson 1999), Advanced Book Exchange3(www.abebook.com), Kasbah (Chavez & Maes 1996), COOPBOT(Milani & Marcugini 1998), ICOMA(Kang et al. 1998), and MAgNET(Dasgupta et al. 1999) are those for merchant brokering.

In the online auction marketplace, online

auction sites such as OnSale(www.onsale.com) and eBay(www.ebay.com) are very popular. Intelligent agents could be used to create contract types in online auctions. A complicated contract type, such as a double auction wherein buyers and sellers submit bids and offers in any order, could be created easier in online auction than real world auction. UNIK-AGENT(Lee & Lee 1998) and AuctionBot(Wurman et al. 1998) are the agents that create contract types. FishMarket(Rodriguez et al. 1997) provides an auction site, where customers can encode several bidding strategies to their agents. AuctionWatch(www.vendio.com) which has changed its name to Vendio is a search engine for items in several auction sites. BiddingBot(Ito et al. 2000a) is one of the shopping support agents in auction sites. Several cooperative bidding mechanisms among agents were proposed(Ito et al. 2000b). A single autonomous agent that can participate in simultaneous multiple auctions was also proposed(Anthony et al. 2001; Preist et al. 2001).

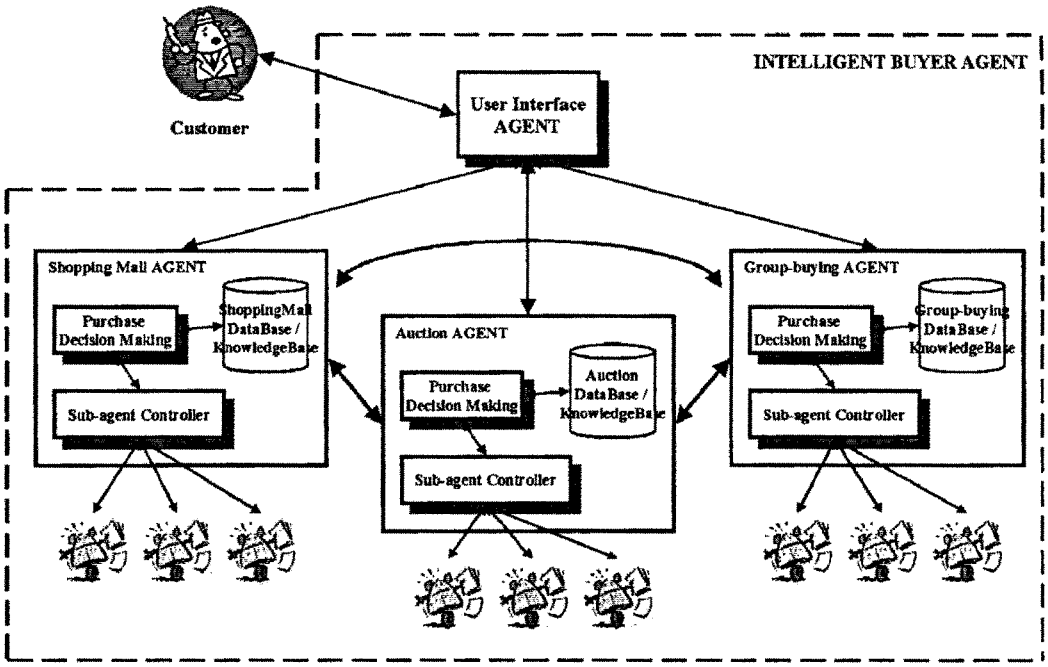
For group-buying marketplace, several researches focus on generating the proposal of appropriate prices of the items being purchased for the sellers(Dasgupta & Das 2000; Maes et al. 1999; Pandey et al. 2000; Song & Lee 2000). GroupBuyAuction(Yamamoto & Sycara 2001) is an agent-based electronic market wherein agents automatically negotiate with each other on behalf of their customers. In particular, buyer agents can form coalitions in order to buy goods at volume discount price. Ito et al.(2001a; 2001b) proposed a cooperation mechanism among seller agents based on exchanging their goods in an agent-mediated electronic market system in order to sell goods in stock effectively whereas buyer agents cooperatively form coalitions in order to buy goods based on discount prices.

On the other hand, researches about cooperation among intelligent agents have a variety of approaches and solutions where cooperation is necessary(Guttman & Maes 1998a; Guttman & Maes 1998b; Ito et al. 2000b; Ito et al. 2001a; Ito et al. 2001b; Ketchpel 1995; Lander & Lesser 1993; Markoff 1996; Nunamaker et al. 1991; Sandholm & Lesser 1995; Shehory & Kraus 1995; Shehory et al. 1999; Yamamoto & Sycara 2001; Yokoo et al. 1992). However, cooperation among intelligent agents in several marketplaces simultaneously has not been examined yet.

3. An Architecture of Intelligent Buyer Agent

To support a customer's purchase decision making in the electronic marketplace, IBA (Intelligent Buyer Agent) consists of four agents operating independently as depicted in [Fig. 1].

The user interface agent mediates interactions between the customer and each agent in charge of purchase decision in the corresponding marketplace. The remaining agents - shopping mall agent, auction agent, and group-buying agent - start on the purchase decision processes when the customer's purchase requirement is passed through the user interface



[Fig. 1] Architecture of Intelligent Buyer Agent

agent. Using their purchase knowledgebase, they make a purchase decision at online shopping mall sites, online auction sites, and online group-buying sites, respectively. Conflict among agents' purchase decisions is resolved through cooperative negotiation. We explain the function of each agent in this section. The decision rules, the contents of knowledgebase of three agents, are described in next section.

(1) Shopping mall agent

After receiving the message from the user interface agent, the shopping mall agent collects information corresponding to the merchant who sells the product that the customer wants to buy. The shopping mall agent always keeps the stored information about online shopping malls such as name, URL, etc. The sub-agent controller of the shopping mall agent triggers all the sub-agents responsible for each shopping mall soon after they receive the customer's requested message. And then the master agent periodically gathers information about a certain merchant from the response message of the corresponding sub-agent.

The purchase decision of the shopping mal' agent is postponed until the finish time designate by the customer because transaction conditi including price are seldom changed in a s period of time. This information is only giv the auction agent and the group-buying while they negotiate cooperatively until th time approaches.

(2) Auction agent

While the auction agent conducts the information gathering and sub-agent launching similar to the previous shopping mall agent, the characteristics of online auction market make the purchase decision process different. In the English auction as one of the three marketplaces in this paper, the bidding price of the product increases from opening time to closing time, and the final transaction price is settled by the highest bidding price in the deadline. To make good purchase decisions in online auctions, the agent should watch the change in bidding prices continuously and participate in auctions with a proper bidding price within a closing time.

A sub-agent triggered by auction agent takes charge of a certain online auction site and informs the status of bidding price for the whole period to the master auction agent. When the deadline for a specific online auction draws near, the auction agent which receives the last informed message from a sub-agent determines whether it makes a bid in the online auction site or not and to which bidding price it submits if it does. This purchase decision is made as a result of the cooperative negotiation with the shopping mall agent and the group-buying agent.

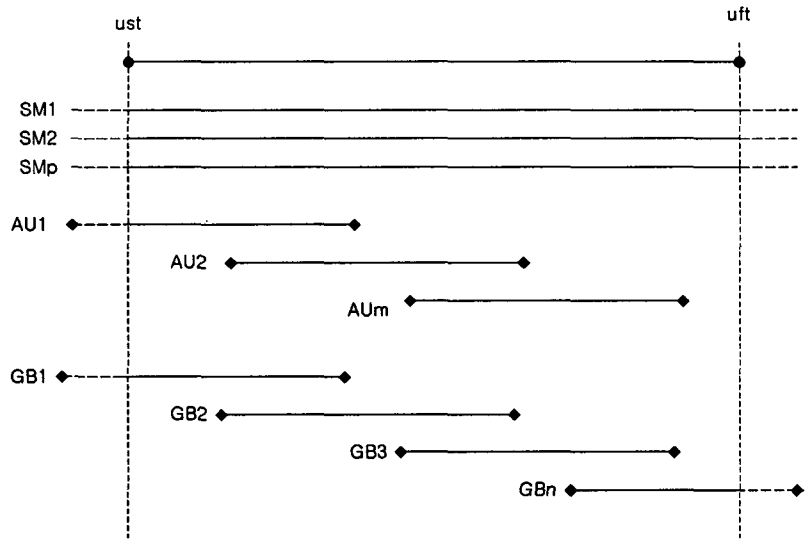
(3) Group-buying agent

The operation of the group-buying agent is almost the same as that of the auction agent except the purchase decision criteria. The transaction price of the product is settled by the number of applicants or the order amounts of the product in the group-buying marketplace. As order amounts increase in group-buying, the price for all participants gets cheaper and becomes fixed. Sub-agents inform the number of participants (total order amount) and the corresponding unit price to the group-buying agent. The group-buying agent then determines whether it joins the group-buying market or not. At that time, the group-buying agent requests the cooperative negotiation with the shopping mall and auction agents.

4. Decision Rules for Shopping

In this section, we will describe the decision rules of purchase decision making through cooperative negotiation among three purchase agents of the IBA (Intelligent Buyer Agent). It is necessary to introduce the concepts and their definitions before describing the process in detail. [Fig. 2] shows a time span for the purchase decision of customer.

There are three types of purchase decision point of time from start time ust to finish time uft. First, when any online auction site for the product reaches the closing time, IBA determines whether it participates in the auction and to which bidding price it submits. Second, IBA determines whether it participates in a certain group-buying site for the product before a deadline of the group-buying, which means that it is the closing time of the group-buying or the number of applicants for the



[Fig. 2] Time Span for Purchase Decision Making

ust : start time designated by customer
uft : finish time designated by customer
SM_i : online shopping mall site i (i=1,2,...,p)
ps_i : selling price at internet shopping mall SM_i
$ps_{min}(t)$: minimum price among ps_i at time t
AU_j : online auction site j (j=1,2,...,m)
(ast_j, aft_j) : opening time and closing time of AU_j
$pa_j(t)$: current bidding price in AU_j at time t
GB_k : group-buying site k (k=1,2,...,n)
(gst_k, gft_k) : opening time and closing time of GB_k
$pg_k(t)$: transaction price in GB_k at time t
pgm_k : minimum price of GB_k

group-buying reach the maximum number of persons. Third, the purchase decision for the product is settled in the finish time designated by the customer.

4.1 Decision at the Deadline of Online Auction Site

The auction agent should judge that the last bidding price $pa_j(aft_j)$ is the cheapest price for all marketplaces, including shopping mall, online auction, and group-buying sites, in order to determine whether it bids in the online auction site AU_j at the closing time.

The participation in the auction and the upper limit of its bidding price are settled according to the result of the judgment as follows. First, in case of shopping mall or group-buying sites in progress where the transaction price is cheaper than the last bidding price, the auction agent never participates in the auction site. Otherwise, the agent should compare the last bidding price with the expected price that reflects the opportunity cost of non-participation in the

auction. If the last bidding price is lower than the expected price, the auction agent participates in the auction with the expected price as an upper bound of its bidding price. The formula to calculate the expected price EP(~AU_j) is as follows:

$$EP(\sim AU_j) = \int_0^{pa_j(aft_j)} p \times fn(p)dp + \int_{pa_j(aft_j)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(aft_j), \underset{i}{Min}\left(E(pg_i(gft_i))\right)\right)$$

fn(p) : probability density function of a newly created marketplace with transaction price *p*

The first part of the formula is the expected price of newly created online auction marketplaces or group-buying marketplaces with lower prices than the current minimum after the *j*th closing auction site. The probability density function *fn(p)* could be obtained from price distribution of the past transactions of auction and group-buying marketplaces. The opportunity cost of abandonment of participation in the auction multiplied by the probability of absence of newly created marketplaces with higher prices than the current minimum after the *j*th closing auction is added to the expected price EP(~AU_j) at the second part of the formula.

4.2 Decision at the Deadline of Group-buying Site

The purchase decision of the group-buying agent is similar to that of the auction agent. The group-buying agent decides to join applicants of the group-buying only if the transaction price is cheaper than the expected price, which reflects the opportunity cost of non-participation in this group-buying. The following formula is used to calculate EP(~GB_k), which is the expected price to be paid later when giving up participation in this group-buying.

$$EP(\sim GB_k) = \int_0^{pg_k(gft_k)} p \times fn(p)dp + \int_{pg_k(gft_k)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(gft_k), \underset{i}{Min}\left(E(pg_i(gft_i))\right)\right)$$

fn(p) : probability density function of a newly created marketplace with transaction price *p*

The formula that expresses the opportunity cost of abandonment of participation to the *k*th group buying is similar to the expected price EP(~AU_j) appearing in section 4.1.

4.3 Decision at the Finish Time

If any purchase decision agents have not determined to buy until the finish time, the marketplace is necessarily determined among shopping malls and group-buying sites of which closing time do not reach the finish time. If there are no ongoing group-buying sites, the shopping mall agent places an order to the online shopping mall with the minimum price. Otherwise, the group-buying agent estimates the final transaction price for each ongoing group-buying marketplace and compares the minimum price among the group-buying sites with the minimum price of online shopping malls. The formula EP(GB_k), which means the expected closing price for group-buying site GB_k, is as follows:

$$EP(GB_k) = E(pg_k(gft_k)) = \sum_{c=0}^{\infty} pn_k(c) \times pgs_k(gc_k(uft)+1+c)$$

$pn_k(c)$: probability mass function that the number of additional participants for GB_k is c from the finish time to the closing time of the site

$pgs_k(c)$: transaction price of GB_k when the number of applicants is c

$gc_k(t)$: number of applicants of GB_k at time t

At the finish time, the shopping mall agent and group-buying agent determine cooperatively the market to buy, comparing the minimum price of online shopping mall sites with the minimum expected price of group-buying sites.

5. Message Layers

5.1 Agent Communication Language Layer

In communicating with other agents, Agent Communication Language(ACL) is necessary. KQML(Knowledge Query and Manipulation Language) and UNIK-OBJECT are used as the outer and inner language of ACL, respectively (Lee & Kim 1996).

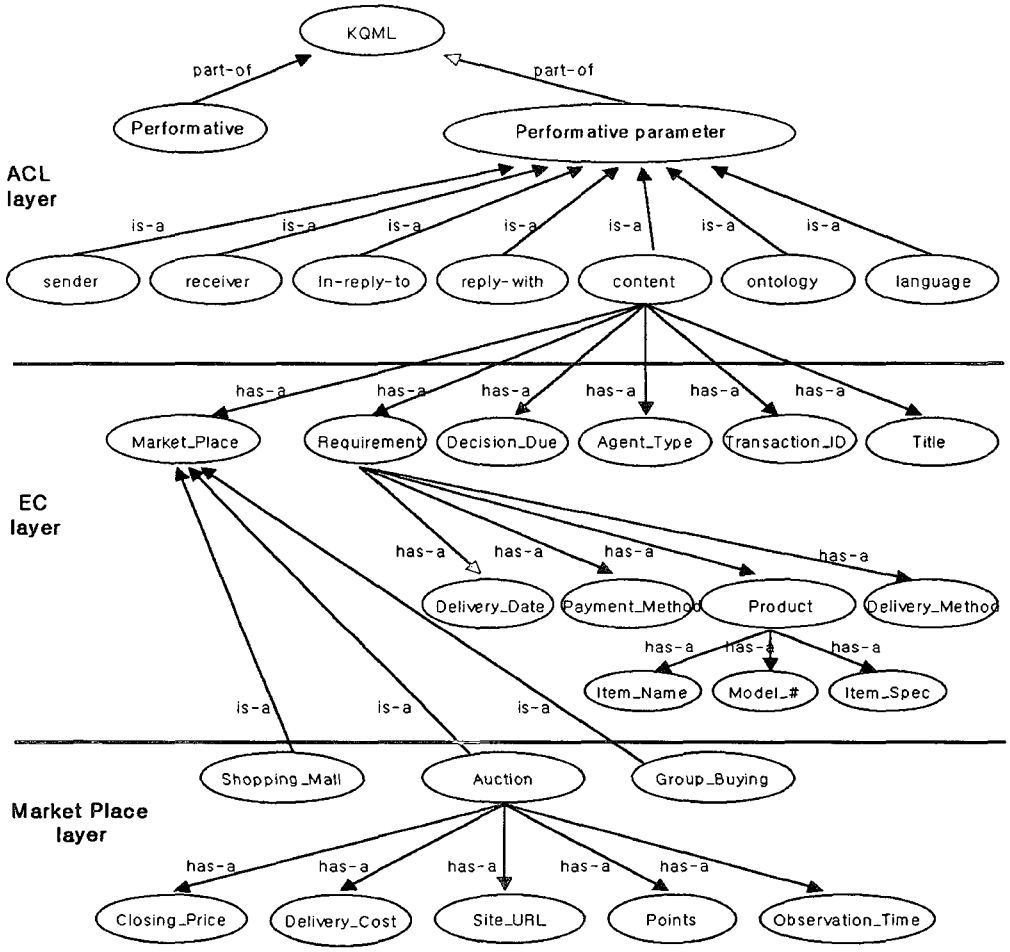
Three message layers similar to the UNIK-AGENT(Lee & Lee 1998) are defined in [Fig. 3] in order to apply ACL and inner language to electronic commerce. The top layer, which is called the ACL layer, consists of a KQML performative and its parameters as domain independent messages(Lee & Lee 1998). Performative parameters: sender, receiver, and content have the values of the agent IDs that send messages and communication objects.

5.2 Electronic Commerce Layer

The middle layer called Electronic Commerce (EC) layer contains the KQML content details. The messages are constructed using TITLE, TRANSACTION_ID, AGENT_TYPE, DECISION_DUE, etc. TITLE has the value of message name. TRANSACTION_ID corresponds to the unique number each activating transaction has. DECISION_DUE contains the due date for making the purchase decision. MARKET_PLACE keeps the value of market types. REQUIREMENT has its own parameters: DELIVERY_METHOD, DELIVERY_DATE, PAYMENT_METHOD, and PRODUCT (Fig. 3). Customers specify their requirements using REQUIREMENT. PRODUCT also has the following parameters: ITEM_NAME, MODEL_#, and ITEM_SPEC. They receive values from a customer. The agents refer to them when searching prices in their marketplace.

5.3 Marketplace Layer

The marketplace layer defines the marketplaces more specifically. Three types of marketplaces are under consideration for searching the minimum price upon customer's request as mentioned before. The components for operating the marketplace and the message for communicating with other agents are defined. For instance, CLOSING_PRICE corresponds to the closing price of an auction; SITE_URL the URL of the auction site to be searched; POINTS a kind of cyber money that the customer can use for shopping; and OBSERVATION_TIME the date



[Fig. 3] Message Layers

and time the price is observed. Because of the page limitation, only the auction part is specified.

6. Solution Procedure

6.1 Initiation of Each Agent: User Input by the User Interface Agent

A customer initiates the search process as he or she specifies requirements to the user interface agent. The requirements consist of item name, model number, manufacturer, and the due date for making a purchase decision. The user interface agent transfers them to the shopping mall agent, the auction agent, and the group-buying agent.

The shopping mall agent, the auction agent, and the group-buying agent trigger their

sub-agents to start searching as they give the customer's requirement and the following data retrieved from each database: site URL, user ID, and password. The following message shows that the shopping mall agent (SM_AGENT) asks its sub-agent (SM_CHILD1) to search the price of the item requested by the customer.

```
(EVALUATE
   : SENDER          SM_AGENT
   : RECEIVER        SM_CHILD1
   : REPLY_WITH      K0061_040708
   : ONTOLOGY        Agent Based Commerce
   : LANGUAGE        UNIK-OBJECT
   : CONTENT
      ((TITLE                  Search_Price)
       (TRANSACTION_ID         SM_040708)
       (MARKET_PLACE           Shopping_Mall)
       (MANUFACTURER           Samsung)
       (ITEM_NAME              NICE)
       (MODEL_#                K0061)
       (SITE_NAME              KYONGGI_SHOP)
       (SITE_URL               www.kyonggi-shop.com)
       (USER_ID                kgu04)
       (USER_PWD               chu07)
       (OBSERVATION_TIME       JULY 8 10:30)))
```

In this manner, the shopping mall agent sends the message to its sub-agents. The auction agent and the group-buying agent also send those kinds of messages to their sub-agents.

6.2 Transaction Information Gathering: Prices, Current Status

The sub-agents gather the information on transaction status. For instance, auction sub-agents look for opening time, closing time, current bidding price, delivery cost, etc. Each shopping mall sub-agent periodically informs the price of the requested item at its corresponding shopping mall to the shopping mall agent after considering points and delivery cost. The following message shows that the sub-agent SM_CHILD1 informs the purchasable price $200 to the shopping mall agent SM_AGENT.

The shopping mall agent acquires the name and URL of the shopping mall that gives the minimum price along with its price and observation time from the shopping mall sub-agents.

The sub-agents of auction and group-buying also gather related information and wait until every event comes to the closing time in order to report to the auction or the group-buying agent.

```
(REPLY
   : SENDER          SM_CHILD1
   : RECEIVER        SM_AGENT
   : IN_REPLY_TO     K0061_040708
   : ONTOLOGY        Agent Based Commerce
   : LANGUAGE        UNIK-OBJECT
   : CONTENT
      ((TITLE                  Price)
       (TRANSACTION_ID         SM_040708)
       (MARKET_PLACE           Shopping_Mall)
       (MANUFACTURER           Samsung)
       (ITEM_NAME              NICE)
       (MODEL_#                K0061)
       (SITE_NAME              KYONGGI_SHOP)
       (SITE_URL               www.kyonggi-shop.com)
       (POINTS                 20)
       (DELIVERY_COST          40)
       (PURCHASE_PRICE         200)
       (OBSERVATION_TIME       July 8 15:00)))
```

6.3 Decision Request of Auction(or Group-buying) Sub-agents at Each Decision Time

At each decision time, the corresponding sub-agent reports the current transaction status and asks whether to participate or not. The same procedure is applied to both auction and

group-buying marketplace, and the auction case is described here.

(1) Request on the Minimum Price from the Shopping Mall Agent

The auction agent AUC_AGENT sends the message to the shopping mall agent SM_AGENT asking for the current minimum price of the item among shopping malls as follows:

```
(EVALUATE
  : SENDER          AUC_AGENT
  : RECEIVER        SM_AGENT
  : REPLY_WITH      K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                MIN_Price)
      (TRANSACTION_ID       Request_SM_040708)
      (MARKET_PLACE         Shopping_Mall)
      (MIN_PRICE                 )))
```

The shopping mall agent then informs the current minimum price to the auction agent.

```
(REPLY
  : SENDER          SM_AGENT
  : RECEIVER        AUC_AGENT
  : IN_REPLY_TO     K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                MIN_Price)
      (TRANSACTION_ID       Request_SM_040708)
      (MARKET_PLACE         Shopping_Mall)
      (MIN_PRICE            200)))
```

(2) Request on the Minimum Estimated Price from the Group-buying Agent

The auction agent AUC_AGENT sends the message to the group-buying agent GB_AGENT asking for the minimum estimated price of the item among the active group-buying marketplaces. The group-buying agent then sends the message asking for the estimated prices of the item to the group-buying sub-agents.

After receiving the estimated prices from the sub-agents, the group-buying agent selects to inform the minimum estimated price among them to the auction agent as follows:

```
(REPLY
  : SENDER          GB_CHILD1
  : RECEIVER        GB_AGENT
  : IN_REPLY_TO     K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                Estimated_Price)
      (TRANSACTION_ID       Request_GB_040708)
      (MARKET_PLACE         Group_Buying)
      (ESTIMATED_PRICE      195)))

(REPLY
  : SENDER          GB_AGENT
  : RECEIVER        AUC_AGENT
  : IN_REPLY_TO     K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                MIN_Price)
      (TRANSACTION_ID       Request_GB_040708)
      (MARKET_PLACE         Group_Buying)
      (MIN_EST_PRICE        180)))
```

(3) Request on the Estimated Price from Active Auction Sub-agents

All the sub-agents of active auctions except the closing one report their estimated prices to the auction agent. They estimated the prices using the formula mentioned in section 4.1.

6.4 Purchase Decision using Each Expected Price

The auction agent calculates the expected

price of each marketplace in order to decide whether to buy or not. For instance, in the auction marketplace, the expected price when the agent does not participate in the auction can be calculated using the following formula in section 4:

$$EP(\sim AU_j) = \int_0^{pa_j(aft_j)} p \times fn(p)dp + \int_{pa_j(aft_j)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(aft_j), Min_i\left(E(pg_i(gft_i))\right)\right)$$

fn(p) : probability density function of a newly created marketplace with transaction price *p*

Means and variances of the distribution *fn(p)* can be obtained from the database. Assume that a closing price of the auction is $190. If the expected price is greater than $190, the corresponding auction sub-agent can participate in the bidding process of that auction. The auction agent notifies the intermediate result to the user interface agent or to the shopping mall agent and the group-buying agent depending on whether the purchase decision has been made or not as follows:

```
(TELL
  : SENDER          AUC_AGENT
  :      RECEIVER       SM_AGENT       GB_AGENT
  (USER_INTERFACE_AGENT)
  : REPLY_WITH      K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                    Intermediate_Result)
      (TRANSACTION_ID           Transact_040708)
      (EP_AUC                   210)
      (EP_GB                    205)
      (EP_SM                    200)
      (MIN_VALUE                N)
      (DECISION                 CONTINUE)))
```

6.5 Customer's Designated Decision Finish Time

The shopping mall agent asks the group-buying agent for the minimum value among estimated closing prices of active group-buying marketplaces if the purchase decision has not been made until the customer's designated decision finish time. The purchase decision depends on the comparison result of the minimum values between two marketplaces.

6.6 Notification of Ordering Result

Finally, the marketplace (for instance, the group-buying marketplace) is determined, and the ordering result is notified to all the agents and the customer as the following:

```
(TELL
  : SENDER          GB_AGENT
  :      RECEIVER       SM_AGENT       AUC_AGENT
  USER_INTERFACE_AGENT
  : REPLY_WITH      K0061_040708
  : ONTOLOGY        Agent Based Commerce
  : LANGUAGE        UNIK-OBJECT
  : CONTENT
     ((TITLE                    Final_Result)
      (TRANSACTION_ID           Transact_040708)
      (SITE_NAME                Onket)
      (SITE_URL                 www.onket.com)
      (PURCHASING_PRICE         195)
      (ORDERING_DATE            20040712)
      (MIN_MARKETPLACE          GB)
      (MIN_VALUE                Y)
      (DECISION                 STOP)))
```

7. Conclusions

We have proposed a customer's purchase decision making method and design of the

Intelligent Buyer Agent that searches and compares the transaction conditions related to the price in multiple marketplaces. In order to overcome the limitation of comparison-pricing model in online shops, the master agents of the Intelligent Buyer Agent make the appropriate purchase decision in their corresponding marketplaces and negotiate cooperatively to reach the optimal purchase decision as a whole. The Intelligent Buyer Agent could expand to different kinds of marketplaces, which would eventually maximize the customer's utility.

As a following study, we consider the implementation of the Intelligent Buyer Agent and performance evaluation, comparing the results of each marketplace.

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References

Anthony, P., Hall, W., Dang, V. D., and Jennings, N. "Autonomous agents for participating in multiple on-line auctions," In *Proceedings of IJCAI Workshop on E-Business and the Intelligent Web*, Seattle, WA., 2001.

Chavez, A., and Maes, P. "Kasbah: An agent marketplace for buying and selling goods," In Proceedings of 1st International Conference and Exhibition on the Practical Application of Intelligent Agents and Multi-Agents (PAAM96), 1996, 75-90.

Dasgupta, P., Narasimahn, N., Moser, L. E., and Melliar-Smith, P. M., "MAgNET: Mobile Agents for Networked Electronic Trading," *IEEE Transactions on Knowledge and Data Engineering*, Vol.11, No.4(1999), 509-525.

Dasgupta, P., Das, R., "Dynamic Service Pricing for Brokers in a Multi-Agent Economy," *Proceedings of 4th International Conference on MultiAgent Systems*, Boston, USA, July 2000, 375-376.

Guttman, R. H., Moukas, A. G., and Maes, P. "Agent-mediated electronic commerce: A survey," *The Knowledge Engineering Review*, Vol.13, No.2(1998), 147-159.

Guttman, R. H., and Maes, P. "Agent-mediated integrative negotiation for retail electronic commerce," In *Proceedings of the 2nd International Workshop on Cooperative Information Agents (CIA'98)*, 1998a.

Guttman, R. H., and P. Maes. "Cooperative vs. Competitive Multi-Agent Negotiations in Retail Electronic Commerce." *Proceedings of the Second International Workshop on Cooperative Information Agents (CIA'98)*, Paris, France, July 3-8, 1998b.

Ito, T., Fukuta, N., Shintani, T., and Sycara, K., "BiddingBot: A multi-agent support system for cooperative bidding in multiple auctions," In *Proceedings of the 4th International Conference on Multi-Agent Systems (ICMAS-2000)*, 2000a, 399-400.

Ito, T., Fukuta, N., Yamada, R., Shintani, T., and Sycara, K., "Cooperative Bidding Mechanism among Agents in Multiple Online Auctions," in Proceedings of the 6th Pacific Rim International Conference on Artificial Intelligence (PRICAI-2000), 2000b, p.810.

Ito, T., Ochi, H., and Shintani, T., "A Group Buy Protocol based on Coalition Formation for Agent-mediated E-Commerce," In the

Proceedings of the second International Conference on Software Engineering, Artificial Intelligence, Networking & Parallel/ Distributed Computing (SNPD'01), 2001a, 921-927.

Ito, T., Hattori, H., and Shintani, T., "A Cooperation Mechanism among Seller Agents based on Exchanging Goods in Agent-mediated Electronic Commerce," PAIS2001, 2001b.

Kang, J. Y., Song, J. I., Lee J. G., and Lee, E. S., "ICOMA: Agent-based Intelligent Electronic Commerce System on the Internet," *Proceedings of International Conference on Electronic Commerce '98*, Seoul, Korea, April 6-9, 1998, 23-29.

Ketchpel, S., "Coalition Formation Among Autonomous Agents," C. Castelfranchi and J. Muller, (eds.), From Reactions to Cognition: *Proceedings of MAAMAW'93*, Lecture Notes in Artificial Intelligence, Springer Verlag Publishers, 1995, p.957.

Lander, S., and Lesser, V., "Understanding the Role of Negotiation in Distributed Search Among Heterogeneous Agents," In *the Proceedings of the Thirteenth International Joint Conference on Artificial Intelligence*, Chambery, France, August 1993.

Lee, J. K., and Kim, J., "Agent consistency maintenance protocol," *Working Paper, Korea Advanced Institute of Science and Technology*, 1996.

Lee, J. K., and Lee, W., "An Intelligent Agent-Based Competitive Contract Process: UNIK-AGENT," *International Journal of Intelligent Systems in Accounting, Finance & Management*, 1998, 91-105.

Lee, S. K., Lee, J. K. and Lee, K. J., "Customized Purchase Supporting Expert System: UNIK-SES," *Expert Systems with Applications*, Vol.11, No.4(1996), 431-441.

Markoff, J. "Can Xerox auction off hot air?" in: The New York Times, June 24, 1996, D5.

Maes, P., Guttman, R. H., and Moukas, A. G., "Agents that Buys and Sell," *Communications of the ACM*, Vol.42, No.3(1999), 81-91.

Milani, A., and Marcugini, S., "COOPBOT: Distributed Cooperating Agents for Electronic Market," *Proceedings of International Conference on Electronic Commerce '98*, April 6-9, Seoul, Korea, 1998, 30-42.

Murch, R., and Johnson, T., *Intelligent Software Agents*, Prentice Hall, Inc., A Simon & Schuster Company, Upper Saddle River, NJ., 1999.

Nunamaker, J. F., Jr., Dennis, A. R., Valacich, J. S., and Vogel, D. R., "Information Technology for Negotiating Groups: Generating Options for Mutual Gain," *Management Science*, October 1991.

Pandey, V., et. al., "Financial Advisor Agent in a Multi-Agent Financial Trading Systems," *Proceedings of 11th International Conference on Database and Expert Systems Applications*, London, UK, Sept. 2000, 482-486.

Preist, C., Bartolini, C., and Phillips, I., "Algorithm Design for Agents which participate in Multiple Simultaneous Auctions," in F. Dignum, and U. Cortes (eds.), *Agent-Mediated Electronic Commerce 2000 Workshop*, Springer, 2001, 139-154.

Rodriguez, J. A., Noriega, P., Sierra, C., and Padget J., "FM96.5:A Java-based Electronic Auction House," In Proceedings of 2nd International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM97), 1997.

Sandholm, T., and Lesser. V., "Coalition Formation among Bounded Rational Agents," 14th International Joint Conference on Artificial Intelligence (IJCAI'95), Montreal, Canada, 1995.

Shehory, O., and Kraus. S., "Coalition Formation among Autonomous Agents: Strategies and Complexity," C. Castelfranchi and J. Muller (eds.), From Reactions to 10 Cognition: *Proceedings of MAAMAW'93*, Springer Verlag Publishers, Lecture Notes in Artificial Intelligence, 1995.

Shehory, O., Kraus, S., Yadgar, O., "Emergent cooperative goal-satisfaction in large-scale automated-agent systems," *Artificial Intelligence*, Vol.110, No.1(1999), 1-55.

Song, J., Lee, B. S., "Pricing Based QoS Control Framework," *Proceedings of 11th International Conference on Networks*, Singapore, Sept. 2000, 302-306.

Wilder, C., "Intelligent Agents Add Spark To Electronic Commerce," Accenture Technology Lab, 1995.

Wurman, P. R., Wellman, M. P., and Walsh, W. E., "The Michigan Internet AuctionBot: A Configurable Auction Server for Human and Software Agents," In *Proceedings of the Second International Conference on Autonomous Agents*, Minneapolis, MN, USA, May 1998.

Yamamoto, J., and Sycara, K., "A Stable and Efficient Buyer Coalition Formation Scheme for E-Marketplaces," In *Proceedings of the 5th International Conference on Autonomous Agents (Agents'2001)*, 2001, 576-583.

Yokoo, M., Durfee, E., Ishida, T., and Kuwabara, K., "Distributed Constraint Satisfaction for Formalizing Distributed Problem Solving," In *the Proceedings of the 12th IEEE International Conference on Distributed Computing Systems*, 1992.

요약

전자상거래에서의 소비자 구매의사결정을 지원하는 지능형 에이전트 시스템의 설계

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인터넷의 급속한 발전으로 인하여 구매고객들의 구매 방식이 인터넷을 통하여 구매하는 방식으로 변해 가고 있다. 전자상거래에 참여한 소비자는 보다 저렴한 가격으로 제품을 구매하기 위하여 온라인 쇼핑몰을 스스로 탐색하거나 가격을 비롯한 여러 가지 기준에 따라 구매조건을 비교해주는 가격비교 사이트를 이용한다. 또는 온라인 경매 시장이나 공동구매 시장을 통하여 동일한 제품을 구매하기도 한다. 그러나 많은 쇼핑몰과 온라인 경매, 온라인 공동구매 시장에서는 동일한 제품에 대해 서로 다른 가격 결정방식에 따라 거래가 이루어지고 있다. 특히 온라인 경매나 온라인 공동구매의 경우에는 구매 가능한 시간이 제한될 뿐만 아니라 시간이 흐름에 따라 가격이 변화한다. 따라서 소비자들이 서로 다른 가격 결정 방식을 이해하고 이를 이용하여 여러 시장을 동시에 고려한 최적의 구매 의사결정을 내리는 것은 매우 어렵다. 이러한 한계를 극복하기 위하여 여러 시장에서의 시간에 따른 가격의 변화를 동시에 고려하며 소비자의 구매의사결정을 지원하는 의사결정 규칙과 문제해결 절차가 필요하다. 이러한 목적을 위해 각각의 시장에서의 구매의사결정은 소비자의 효용을 극대화시켜야 하며, 각각의 시장에서의 구매의사결정들은 조정과 협력을 통하여 전체 시장을 포괄하는 최적의 의사결정이 되어야 한다. 본 연구에서는 여러 가지 종류의 시장을 대상으로 구매의사결정을 하는 경우에 상호협동적으로 협상을 수행하는 방법론, 즉 규칙과 문제해결 절차를 개발하였고, 이를 수행할 수 있는 지능형 에이전트 시스템의 기본 구조와 협력적 협상을 수행하는데 필요한 메시지 구조를 설계하였다.

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