Agent Based E-Market: Framework, Design, and Implementation

Khubaib Ahmed Qureshi*

ABSTRACT

Attempt has been made to design and develop a complete adoptive Multi Agent System pertaining to merchant brokering stage of Customer Buying Behaviour Model with the intent of appropriate framework. Intelligent agents are autonomous entity which observe and act upon an environment. In general, they are software robots and vitally used in variety of e-Business applications. This paper focuses on the discussions on electronic markets and the adoptive role, which agents can play in information transformation for automating e-market transactions. It is proposed to develop a framework for agent-based electronic markets for buyers and sellers totally with the assistance of software agents.

JEL Classification: O31; D85; G14; G24;

Keywords: Agent Oriented e-Business, Agent Oriented e-Markets, Buyer/Seller Agents, Java, Multi Agent Systems

1. INTRODUCTION

Software agents are programs to which one can delegate (aspects of) a task. They differ from traditional software in that they are personalized, continuously running and semi-autonomous. These qualities make agents useful for a wide variety of information and process management tasks (Maes 1994). It should come as no surprise that these same qualities are particularly useful for the information-rich and process-rich environment of e-commerce.

Electronic commerce encompasses a broad range of issues including security, trust, reputation, law, payment mechanisms, advertising, ontologies, on-line catalogs, intermediaries, multimedia shopping experiences, and back-office management. Agent technologies can be applied to any of these areas where a personalized, continuously running, semi-autonomous behavior is desirable. However, certain characteristics will determine to what extent agent technologies are appropriate. For

* Associate Professor, Head of Information Technology Department, Hamdard Institute of Management Sciences, Hamdard University, khubaib_ahmed@yahoo.com

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example, how much time or money could be saved if a certain process was partially automated (e.g., comparing products from multiple merchants)? How easy is it to express your preferences for the task (e.g., shopping for a gift)? What are the risks of an agent making a sub-optimal transaction decision (e.g., making stock market buying and selling decisions or buying a car)? What are the consequences for missed opportunities (e.g., not being able to effectively monitor new job postings)? Generally, the more time and money that can be saved through automation, the easier it is to express preferences, the lesser the risks of making sub-optimal transaction decisions, and the greater the loss for missed opportunities, the more appropriate it is to employ agent technologies in electronic commerce.

Software agents will play an increasing variety of roles as mediators in electronic commerce (Bailey and Bakos 1997), which is smartly surveyed by Kurbel and Loutchko (2001). This paper explores these roles, their supporting technologies, and how they relate to electronic commerce with the intent of appropriate design (see figure 1) and appropriate proposed framework.

Figure-1: Appropriate Proposed Framework

2 CONSUMER BUYING BEHAVIOR (CBB) MODEL
There are several descriptive theories and models that attempt to capture consumer buying behavior, although all these different models share similar lists of six fundamental stages guiding consumers’ buying behavior. These six stages also elucidate where agent technologies apply to the consumer shopping experience and allow us to more formally categorize existing agent-mediated electronic commerce systems (see figure 2):

2.1 Fundamental Stages Guiding Consumers Behaviour

i. Need Identification

This stage characterizes the consumer becoming aware of some unmet need. Within this stage, the consumer can be stimulated through product information.

ii. Product Brokering

This stage comprises the retrieval of information to help determine what to buy. This encompasses the evaluation of product alternatives based on consumer-provided criteria. The result of this stage is the “consideration set” of products.

iii. Merchant Brokering

This stage combines the “consideration set” from the previous stage with merchant-specific information to help determine who to buy from. This includes the evaluation of merchant
alternatives, based on consumer-provided criteria (e.g., price, warranty, availability, delivery time, reputation, etc.).

iv. Negotiation

This stage is about how to determine the terms of the transaction. Negotiation varies in duration and complexity depending on the market. In traditional retail markets, prices and other aspects of the transaction are often fixed leaving no room for negotiation. In other markets (e.g., stocks, automobile, fine art, local markets, etc.), the negotiation of price or other aspects of the deal are integral to product and merchant brokering. Traditional CBB models do not identify this stage explicitly, but the conclusion of the Negotiation stage is comparable to the Choice or Decision stage found in other models.

v. Purchase and Delivery

The purchase and delivery of a product can either signal the termination of the negotiation stage or occur sometime afterwards (in either order). In some cases, the available payment (e.g., cash only) or delivery options can influence product and merchant brokering.

vi. Product Service and Evaluation

This post-purchase stage involves product service, customer service, and an evaluation of the satisfaction of the overall buying experience and decision Zhang and Cohen (2006). The nature of this stage (and others) depends upon for whom the product was purchased. As with most models, these stages represent an approximation and simplification of complex behaviors. As noted, CBB stages often overlap and migration from one to another can be non-linear and iterative.

From this CBB perspective, we can identify the roles of agents as mediators in electronic commerce (He, Jennings and Leung 2003). The personalized, continuously-running autonomous nature of agents makes them well-suited for mediating those consumer behaviors involving information filtering and retrieval, personalized evaluations, complex co-ordinations, and time-based interactions.

2.2 e-Market Applications and their Role

i. Persona Logic

Persona Logic is a tool that enables consumers to narrow down the products that best meet their needs by guiding them through a large product feature space. The system filters out unwanted products within a given domain by allowing shoppers to specify constraints on a product’s features. A constraint satisfaction engine then returns an ordered list of only those products that satisfy all of the hard constraints.

ii. Firefly

Firefly recommends products via a “word of mouth” recommendation mechanism called Automated Collaborative Filtering (ACF). ACF first compares a shopper’s product ratings with those of other shoppers. After identifying the shopper’s “nearest neighbors” (i.e., users with similar tastes), ACF
recommends products that they rated highly but which the shopper has not yet rated, potentially resulting in serendipitous finds. Essentially, Firefly uses the opinions of like-minded people to offer recommendations. The system is currently used to recommend commodity products such as music and books.

iii. Jango

Jango can be viewed as an advanced Bargain Finder. The original Jango version solved the merchant blocking issue by having the product requests originate from each consumer’s Web browser instead of from a central site as in Bargain Finder. This way, requests to merchants from a Jango-augmented Web browser appeared as requests from ‘real’ customers. This kind of aggressive interoperability

Jango’s modus operandi is simple: once a shopper has identified a specific product, Jango can simultaneously query merchant sites (from a list now maintained by Excite, Inc.) for its price. These results allow a consumer to compare merchant offerings on price.

iv. Kasbah

The MIT Media Lab’s Kasbah (Charvez and Maes 1996) is an on-line, multiagent classified ad system. A user wanting to buy or sell a good creates an agent, gives it some strategic direction, and sends it off into a centralized agent marketplace. Kasbah agents proactively seek out potential buyers or sellers and negotiate with them on behalf of their owners. Each agent’s goal is to complete an acceptable deal, subject to a set of user-specified constraints such as a desired price, a highest (or lowest) acceptable price, and a date by which to complete the transaction. The latest version of Kasbah incorporates a distributed trust and reputation mechanism called the Better Business Bureau. Upon the completion of a transaction, both parties may rate how well the other party managed their half of the deal (e.g., accuracy of product condition, completion of the transaction, etc.). Agents can then use these ratings to determine if they should negotiate with agents whose owners fall below a user-specified reputation threshold.

v. AuctionBot

AuctionBot is a general purpose Internet auction server at the University of Michigan. Auction Bot users create new auctions to sell products by choosing from a selection of auction types and then specifying its parameters (e.g., clearing times, method for resolving bidding ties, the number of sellers permitted, etc.). Buyers and sellers can then bid according to the multi-lateral distributive negotiation protocols of the created auction. In a typical scenario, a seller would bid a reservation price after creating the auction and let AuctionBot manage and enforce buyer bidding according to the auction protocol and parameters.

What makes AuctionBot different from most other auction sites, however, is that it provides an Application Programmable Interface (API) for users to create their own software agents to autonomously compete in the AuctionBot marketplace. Such an API provides a semantically sound interface to the marketplace. It is left to the users to encode their own bidding strategies. Fish market is not currently being used as a real-world system, but it has hosted tournaments to compare opponents’ hand-crafted bidding strategies along the lines of Axelrod’s prisoner’s dilemma tournaments.
vi. Tete-a-Tete

Tete-a-Tete provides a unique negotiation approach to retail sales. Unlike most other on-line negotiation systems, which competitively negotiate over price, Tete-a-Tete agents cooperatively negotiate across multiple terms of a transaction e.g., warranties, delivery times, service contracts, return policies, loan options, gift services, and other merchant value added services. Like Kasbah, this negotiation takes the form of multi-agent, bilateral bargaining but not using simple raise or decay functions as in Kasbah. Instead, Tete-a-Tete shopping agents follow an argumentative style of negotiation with sales agents and use the evaluation constraints captured during the Product Brokering and Merchant Brokering stages as dimensions of a multi-attribute utility. This utility is used by a consumer’s shopping agent to rank order merchant offerings based on how well they satisfy the consumer’s preferences. In essence, Tete-a-Tete integrates all three of the Product Brokering, Merchant Brokering, and Negotiation CBB stages.

3. FUNCTIONAL SPECIFICATIONS

- Each Store agent represents one retail store and knows the prices and available quantities of the products in its store. Store agents receive requests for price quotes from the Buyer agents and respond by telling the Buyer agent the prices, shipment costs and quantities that they can deliver.

- Agents will be capable of communicating with each other over an intranet or the Internet. These agents communicate with each other using the Knowledge Query and Manipulation Language (KQML).

- Each agent has a graphical interface that allows the user to control the operation of the agent or examine the status of agent activity. The Buyer agent's interface allows the user to select a product and quantity to purchase.

- A pull down menu lists the known products and a text field is available for specifying the quantity to be purchased.

- Pressing the Shop button will cause the Buyer agent to begin shopping for the specified product and quantity.

- Pressing the Quit button will cause the Buyer agent to send messages to shut down all of the Store agents and then shut down itself.

- Each agent interface also displays the agent's inventory, account balance, and the agent's activities.

- After the user selects a product and quantity and clicks on the Shop button, the Buyer agent sends requests for price quotes to the Store agents. The Store agents respond with price quotes for the specified product. The Buyer agent decides which store has the lowest price and sends a purchase request to the Store agent with the lowest price.

- The Store agent then confirms the purchase, decreases its available inventory, adds the purchase price to its account balance, and sends a purchase confirmation message to the Buyer.
agent. After receiving the purchase confirmation, the Buyer agent increases its inventory and subtracts the purchase price from its account balance.

4. KNOWLEDGE BASE

4.1 Knowledge Representation

There are different methods of knowledge representation like:

- Rules
- Objects
- Frames

In Buyer/Seller Agency we have followed Rule Based Knowledge Representation which is very flexible and compatible way of representing heuristics.

4.2 Inference Method

There are two standard methods of inference.

i. Forward Chaining – Data Driven Approach
ii. Backward Chaining – Goal Driven Approach

Buyer/Seller Agency is making use of Data Driven Approach which is also called Forward Chaining for Selection of best offer according to Buyer’s preferences (parameters).

iii. Buyer’s Preferences

Buyer Agent will be informed about the following parameters (price of the product, ranking of the seller, and flexibility required in shipment period) against which the best offer will be selected.

iv. Selection Criteria

Buyer Agent will deliver Price, Preferences, and Selected Ranking to the Facilitator Agent (Agency), which will intelligently select appropriate ranked sellers. Facilitator will send Request to the selected sellers. Seller will check its inventory for sufficient quantity of the required product and its shipment option. Then Seller sends an Offer to the Buyer providing non-negotiable price with shipment period. After the Deadline offers from the Sellers will be evaluated. The evaluation will be done on the basis of price and shipment period against the preferences provided by Buyer. For example, in case of higher price preference, offer for higher price will be given priority over lower priced offers. Similarly an offer within stipulated time frame will be given higher priority.

Some of the possible options for Buyer’s preferences are described below:

i) Price (i) High (ii) Medium (iii) Low

ii) Ranking (i) High (ii) Medium (iii) Low
iii) Shipment Period (i) On Stipulated time (ii) Within 20% of stipulated time (iii) With 40% of stipulated time

Figure 3 represents the Execution Process of an Agent and how an agent’s mental model is changed in its decision making process.

5. KQML

There are different languages for multi-agent interaction (Polad 2007). Including Knowledge Query and Manipulation Language (KQML) which is a high-level language intended to support interoperability among intelligent agents in distributed applications. It is both a message format and a message-handling protocol to support runtime knowledge sharing among agents. KQML can also be used for two or more intelligent systems to share knowledge in support of cooperative problem solving.

Why:
- Existing protocols, such as RPC, are insufficient.
- Nor are there standard models for programming in an environment where some of the data is supplied by processes running on remote machines and some of the results are needed by other similarly distant processes.
- Must be easy and flexible to communicate.

5.1 Layer of Communication

Agents may have different, and even conflicting, agendas. KQML message is defined in terms of constraints on the message sender rather than the message receiver who choose a course of action that is compatible with other aspects of its function and strive for maximal cooperation. KQML language can be viewed as being divided into three layers (see figure 3)

- Content layer,
- Message layer,
- Communication layer.

Figur-3: KQML language Layers of communication

Source: Generated by author
5.2 Content Layer

KQML can carry any representation language, including languages expressed as ASCII strings and those expressed using a binary notation.

5.3 Communication Layer

Encodes a set of features to the message which describe the lower level communication parameters, such as the identity of the sender and recipient, and a unique identifier associated with the communication.

5.4 Message Layer

The message layer forms the core of the language. The primary function of the message layer is to identify the protocol to be used to deliver the message and to supply a speech act, or performative, which the sender attaches to the content. The performative signifies that the content is an assertion, a query, a command, or any of a set of known performatives.

5.5 Message Parts

A KQML message consists of a performative, its associated arguments which include the real content of the message, and a set of optional arguments. The main focus of KQML is on its extensible set of performatives, which defines the permissible operations that agents may attempt on each other’s knowledge and goal stores at run time.

Example:

(ask :content (prodoffer purchase(?prod, ?price, ?days) )
 :sender buyer1
 :receiver seller1
 :in-reply-to <label of the reply>
 :reply-with <label to be replied>
 :language KQML
 :ontology buyer-seller)

5.6 Ontologies

It describes relevant objects and relations in a domain (Albert, Jonker, Karami and Treur 2004) as shown in figure 4.

Figure-4: relevant objects and relations in a domain
6. DESIGN

Required appropriate design, which is cultivated through various related research work/projects executions (Huang and Lin 2005; Mariano et al., 2001; Joo, Knoshtia, and Shirtori 2000; Maes, Guttman and Moukas 1999; Guttman Maes, Chavez, and Dreiliger 1997).

6.1 Agent Roles and Description

There will be three types of agents in the marketplace facilitator: Seller and Buyer agents (see figure 5), following proper protocol for their complete sets of interactions in the execution of electronic market (see figure 6).

i. Agents in Market Place

i) Facilitator Activities performed by Facilitator are:

- maintainSignInInfo
  Facilitator maintains information of Buyer and Seller Agents, who have signed in and are active. So Facilitator will send and receive messages from active agents only.

- maintainSignOutInfo
  Facilitator keeps a check when the Buyer or Seller has signed out. After sign out it marks its status as inactive.

- listenBuyRequests
  Facilitator listens for the buy requests from the buyer.

- receiveBuyRequest

Source: Albert, Jonker, Karami and Treur 2004
As soon as the listener listens to a buy request, this method receives the buy request and stores it in its own memory. This method also automatically triggers the sendBuyerRequest method.

- **sendBuyerRequest**

This method checks the Buy Request. It looks for Product Specifications and Buyer's Preferences. It sends the Buyer's Request to only those Sellers who are active and which fulfill the buyer's preferences.

- **receiveSellerOffer**

Seller sends its offers against Buyer's Requests. These offers are received by the Facilitator.

- **sendSellerOfferToBuyer**

Facilitator sends the Offers to the respective buyer.

- **maintainBuyerProfile**

Facilitator maintains buyer profile. How many requests it had made and how many orders it had confirmed. Against this profile it assigns a rating to the buyer.

- **maintainSellerProfile**

Facilitator maintains seller profile. Facilitator assigns it a rating based on its past performance.

**Figur-5: Types of Agents in Marketplace**

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<td>ACTIVESELLERS</td>
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<tr>
<td>ACTIVEBUYERS</td>
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<td>PENDINGREQUESTS</td>
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Source: Generated by author
ii) Buyer
Activities performed by the Buyer are:
- **signIn**
  Whenever the buyer signs in, it informs the Facilitator that it is active and it opens the communications channels.
- **signOut**
  Whenever the buyer signs out, it informs the Facilitator that it is inactive and it will not be able to communicate.
- **sendProfiletoAgency**
  Buyer sends its profile to Facilitator in which its basic information is kept, and this profile can be forwarded to seller if buyer agrees to it.
- **sendRequest**
  Buyer sends request for a specific product. The parameters sent with the Request are quantity required, shipment time and relaxation in it (if any), price preference, and seller’s rating.
- **receiveOffer**
  Buyer receives offers from the sellers via Facilitator.
- **cancelRequest**
  Buyer can cancel a request.
- **chooseBestOffer**
  Buyer can evaluate and then choose best possible offer. Evaluation is done on the basis of preferences given by the end user.
- **finalizeOrder**
  After choosing the best option, buyer confirms the order and then order is finalized. From this stage onwards buyer cannot cancel the order.
- **storeConfirmedOrder**
  Buyer Agent also stores the confirmed order into its own repository for record keeping and future references.

iii) Seller
- **signIn**
  Whenever the Seller signs in, it informs the Facilitator that it is active and it opens the communications channels.
- **signOut**
  Whenever the Seller signs out, it informs the Facilitator that it is inactive and it will not be able to communicate.
- **sendProfiletoAgency**
  Seller sends its profile to Facilitator in which its basic information is kept, and this profile can be forwarded to Buyer if seller agrees to it.
- **receiveRequest**
  Seller receives request from the Buyer for a specific product via Facilitator.
- **sendOffer**
  Seller sends the offer to the Buyer via Facilitator.
- **cancelOffer**
  Seller can cancel an offer.
- **finalizeOrder**
Once buyer accepts Seller’s offer, seller finalizes the order.

- storeConfirmedOrder

Seller Agent stores the confirmed order into its own repository for record keeping and future references.

**Figure 6:**

**AGENT INTERACTION PROTOCOL**

- Request for purchase initiated by Buyer
- Deadline for proposals
- Participant sellers

- Not understood
- Refuse Reason
- Propose
- Refuse
- Commit
- Failure Reason
- Order Confirmation
- Shipmenmt Action
- Cancel Reason
- Not Interested

Source: Generated by author

i. **Underlying Protocols**

- Sockets
- TCP/IP

ii. **Development Tools**

- JCreator (Java Editor)
- JDK 1.4
- Swing Components
- MS Access (RDBMS)
- Concept Building Tool: C#, Jack, Agent Builder (ABUG 2004)

7. **CONCLUSION AND FUTURE DIRECTIONS**

Just like any real-life business, software agents can work on behalf of customer by transforming provided information into knowledge. Buyer/Seller Agency is a system where users create agents to search and filter offers for the purchase and sale of goods on their behalf. In this study it a simple prototype has been built to test the basic concepts and feasibility. Future work is focused on making smarter agents, which is direct able at a more natural level for users. Though this study has only just scratched the surface in terms of making a truly useful system, we are excited about this work and think it has the chance to fundamentally change the way people buy and sell goods and services in the not-too-distant future.
REFERENCES


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