MODELING A BLACKBOARD ARCHITECTURE FOR ELECTRONIC COMMERCE

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Abstract

In this paper, we describe a high-level blackboard architecture for electronic commerce. The architecture relies on the presence of supply, demand, and broker agents. The blackboard includes a user agent to interface with the user to determine criteria and needs for particular services. In addition, we describe an evaluation agent that uses a knowledge based system to determine the acceptance, rejection, or negotiation status of services returned to the blackboard by demand agents. We illustrate the possible computation needed within the blackboard using a hotel service request example.

1. Introduction

With the growth of the Internet in the past several years, many companies are looking to use this form of communication as another medium for providing their services. This new way of doing business is called electronic commerce (Oliver 1996, Hamalainen, Whinston, & Vishik 1996). Electronic commerce involves two or more participants negotiating for a service or an item over the Internet. The participants involved in electronic commerce are usually intelligent agents representing people, so that humans are not bothered with negotiations (Oliver 1996, Brown, Gasser, O'Leary, & Sangster 1995, Etzioni & Weld 1995, Hermans 1996).

The intelligent agent's roles normally revolve around satisfying user demands for information. In general, the agents involved in electronic commerce take on the task of gathering information to meet a variety of user needs. However, O'Leary (Brown, Gasser, O"Leary, & Sangster 1995) suggests that a more comprehensive framework would include both *supply* and *demand* agents. Supply agents provide information to demand agents. Specifically, supply agents effectively configure information for information consumers. Demand agents search for needed information. These agents are typically designed to search the WWW for information to meet user goals. There are several types of these agents being developed at this time. One example is Internet SoftBot which was developed at the University of Washington (Etzioni & Weld 1995). Softbot is a prototype implementation of a high-level assistant. In contrast to systems for assisted browsing or information retrieval, the Softbot can accept high-level user goals and dynamically synthesize the appropriate sequence of Internet commands to satisfy those goals (Etzioni & Weld 1995). A third type of agent may exist, called a *broker* agent, which match supply agent capabilities with demand agent needs (Brown, Gasser, O'Leary, & Sangster 1995).

In this paper, we define a potential architecture and a prototype evaluation agent that works with the supply and demand agents specified by O'Leary (Brown, Gasser, O'Leary, & Sangster 1995) for electronic commerce. A blackboard architecture provides the communication medium in which knowledge sources are represented by demand agents, an evaluation agent, and a user agent. We discuss the generic blackboard model and the evaluation agent in the context of a hotel reservation example.

2. Blackboard Architecture for Electronic Commerce

The blackboard architecture for electronic commerce contains a user agent, several demand agents, an evaluation agent, and a central communication area called a blackboard (see Figure 1). We selected the blackboard architecture for this domain for several reasons. First, a central repository was needed, so that all agents could share acquired information. Blackboard systems are ideally suited to systems that involve shared access to data using loosely coupled agents (Shaw & Garland 1996). In addition, the current state of the

blackboard can serve as the main trigger for selecting processes to execute.

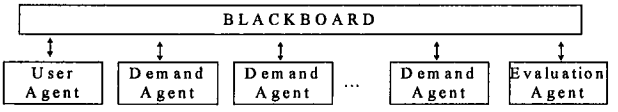

Figure 1: Abstract Model of an Electronic Commerce System

Within the architecture, the user agent receives information from the user about the type of commerce and the factors or criteria that are important. Though user agents communicate with the blackboard in a similar fashion, individual information is domain specific, since the criteria or factors for commerce may be radically different. The user agent only posts user criteria to the blackboard. However, it continues to observe the blackboard for information on the acceptance, negotiation, or rejection of an item or service which may cause a consultation with the user to change the criteria.

Making a hotel reservation is a fairly simple example that can be generalized for consideration in other examples, accommodating the need for simultaneous reservations (Oliver 1996). For example, suppose a person would like to reserve a room in Chicago for two nights and spend between $120 and $150 on the room per night. The hotel should be within two miles of the airport and have a swimming pool and room service. The person would rank these services and the target price range as having the highest priority. The person does not care about any other services the hotel may have. In a hotel reservation example, the user is presented with a form (See Figure 2) that contains many of the attributes found in a hotel. The form would include attribute priorities which later aid the evaluation agent in its decision making. In addition, the form includes a *failure list* to keep track of completely rejected services, in case new searching must be performed.

Hotel Information

City: Miami	Priority: High
Cost Range: 150 - 200	Priority: Low
Dates: 04July97 - 07July97	
Location: Near Airport	Priority: High
Type Room: Suite	Priority: Low
No Rooms: 1	Priority: High

Hotel Services

Room Service:	Priority: High
Laundry:	Priority: None
Cable:	Priority: Low
Gym:	Priority: Low

Failure List:

Figure 2: Example Hotel Information Form for User

Demand agents acquire information pertaining to their specified services as this information is posted to the blackboard. The actual number of demand agents needed in the architecture depends on the application and the service. In the actual process, the evaluation agent posts a template (object) containing the needed information from the user form. Demand agents associate with a particular object in which they will place their solutions. Procedurally, they attach an unique identifier with that object. The demand agents, using the criteria from the user, contact either supply or broker agents that can provide pertinent information, which also includes information in the failure list so that searching is not repeated for rejected services. After a demand agent has collected its sought after information, it posts this information to the blackboard and awaits further instructions. An example of a information returned within our hotel example appears in Figure 3. For simplicity in the first prototype, we have limited the demand agents to only Boolean responses, with the exception of the unique service identification code. Service acquisition and later negotiation with supplier agents is governed by the evaluation agent, which is discussed in the following section.

Demand Agent 1001

Service ID:	02134
City:	TRUE
Cost:	FALSE
Arrive Date:	TRUE
Depart Date:	TRUE
Location:	FALSE
Type Room:	TRUE
No Rooms:	TRUE
Room Service:	TRUE
Laundry:	FALSE
Cable:	TRUE
Gym:	TRUE

Figure 3: Demand Agent Response to Blackboard

3. The Evaluation Agent

In this section, we outline the operation of an evaluation agent within a blackboard model for electronic commerce. This agent contains a knowledge based system (KBS) that currently decides which demand agent services to accept, reject, or negotiate. The evaluation agent retrieves the initial criteria from the user and processes it for the demand agents to conduct their search. Demand agent solutions are examined by the evaluation agent incrementally as they are posted and a determination is made to accept, reject, or negotiate further on each solution. The rules constructed to make the decision are based on the number of high and low priority items returned by the demand agent that match the user information (See Figure 4).

Evaluation Types	Criteria
Accept Service	If # high priority items ≥ 90% and # low priority items ≥ 90% matches with user's initial criteria
Negotiate Service	If 90% > # high priority items ≥ 75% and 90% > # high priority items ≥ 75% matches with user's initial criteria
Reject Service	If # high priority items < 75% and # low priority items < 75% matches with user's initial criteria

Figure 4: Evaluation Rules

The blackboard contains evaluation results that correspond to each demand agent solution. Figure 5 shows the evaluator's results from comparing the demand agent solutions in Figure 3 to the user information in Figure 2.

Evaluator 1001

Total High:	4
Total Low:	4
Match High:	3
Match Low:	3
Decision:	Negotiate
Negotiation:	Cost
	Location

Figure 5: Evaluation Results

The evaluator agent awaits the return of the demand agents seeking a service for the user within a specified period of time. The procedure for selection among multiple services appears in Figure 6.

```
IF Acceptances are present, THEN
    IF only 1 service acceptance,
    THEN select service
    IF 2 or more service acceptances,
    THEN select the service with the maximum
            Match_High field
            IF multiple services still exist,
            THEN select the service with the maximum
                    Match_Low field
                    IF multiple services still exist,
                    THEN choose randomly
IF no Acceptances are present, THEN begin Negotiations
IF all Rejections remain, THEN
    IF user agent responds with changed criteria,
    THEN update object and await demand agent
            response
    IF no criteria are changed,
    THEN enter the codes for the rejected services and
            clear the templates for further demand agent
            searching
```

Figure 6: Analysis of Service Results

If a decision to negotiate a service is determined, the criteria for negotiation are placed in the evaluator's results to direct the user agent. The user agent presents a new form to the user containing all negotiable criteria from the demand agents. Then the user may choose to change all, some, or none of the negotiable information, and then the previous defined cycle is repeated.

4. Conclusion

The goal of this paper was to illustrate a blackboard architecture for electronic commerce that includes an evaluation agent to analyze information and serve as a mediator between the user and the demand agents. We illustrate the high level functionality of the architecture and the evaluation agent prototype knowledge based system. Currently, the knowledge-based system embedded in the evaluation agent is domain independent, which limits any detailed capability.

Additional work is continuing in which multiple services, such as car rental and air carrier are added to the blackboard. Domain dependent rules are being constructed such as acquiring a lower fare on an airline given a Saturday stay and whether the new fare is justified with the extra expense of hotel, rental car, and food. The problem with the addition of and reliance on domain-independent rules is that they will have to be defined, compiled, and verified as new domains are introduced into electronic commerce. Knowledge sharing efforts are likely to be important in developing large scale electronic commerce systems.

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