A 2-Phase Evaluation Model for Agent-mediated Internet Marketplaces

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Abstract

In this paper, we propose a 2-phase evaluation model that can be applied to agent-mediated Internet marketplaces. The model not only facilitates parallel processing, it also allows mobile agents to select online shops (e-shops) and evaluate offers autonomously and automatically. To provide the "best" answer, the approach considers multiple attributes of an e-shop and an offer, such as the commercial credit and security rank of the e-shop, price, delivery/shipment service and warranty service of an offer. Moreover, with the fuzzy-set rules, the evaluation results are more reasonable and accord with human behavior. With the 2-phase evaluation of this model, it can not only help to control the scale of dispatched mobile agent to a rational level to reduce the burden of network traffic, but also help to evaluate offers to assist users to make good decisions.

1. Introduction

The term of electronic commerce encompasses the entire process of buying, selling and advertising products and services using electronic communications media. But when people talk about electronic commerce today, they are usually referring to the emerging marketplace on the Internet. In the last couple of years, the Internet has undergone a transition from a computer network to a mass market of millions of potential consumers. Consumers gain the power to access global online shops on the web to browse and choose goods. Electronic commerce extends the traditional consumer/merchant pattern to a more flexible and convenient stage.

However, it is quite difficult for consumers to find the optimal offers for two reasons. First, consumers' decisions are based on multiple objectives – while he may want to find the cheapest item, he would also want to ensure that the e-shop is reliable or the item can be shipped within a certain period of time. Very often, these objectives conflict, for example, an item may be sold at a higher cost if it requires urgent/immediate delivery. Second, there are many online shops on the web selling similar goods. The consumer has to browse as many sites as possible and compare the offers in order to get the best from them. Hence, though there are many existing online marketplaces, further research and development are necessary to gain experience for providing consumer a more convenient and user-friendly environment.

The recent development in mobile agent technology offers attractive solutions in the field of electronic commerce [3, 9]. The introduction of mobile agents acting on behalf of end-consumers can reduce the effort required from users to conduct electronic commerce transactions by automating a variety of activities [2]. Mobile Agents execute locally to the information servers thus providing better network utilization and better support to mobile users that can disconnect while their agents roam in the network [1, 7].

Though many researches have been done in the domain of agent-assistant electronic commerce, there remain many challenges and problems to be solved in each phase of the commerce processing. Suppose there are hundreds or thousands of shops on the web selling the same kind of goods. It is unnecessary and impossible for a consumer or even an agent to browse all of them. So it is quite necessary and reasonable to evaluate these shops and get the best for further transaction. This evaluation process not only resembles how human behaves, but also can reduce the network burden. Also the number of offers may be several times of the number of shops since a shop may provide multiple offers to a consumer. The consumer should evaluate the offers and select promising ones for further negotiation with the shops.

In this paper, we present a 2-phase evaluation model that allows consumer agents to select online shops and evaluate offers autonomously and automatically. This evaluation model consists of two phases: shop evaluation and offer evaluation. The 2-phase mechanism not only resembles consumer behavior, but also makes the evaluation process more efficient. The model allows evaluating multiple attributes of shops and offers, such as commercial credit of the shop, price of goods, warrantee or shipping fee, by special scoring functions. Moreover, with the fuzzy-set rules, the evaluation results are more reasonable and accord with human behavior. With this evaluation model, a consumer can choose a very small set from a list of sorted results to compare even dispatch a

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new mobile agent to negotiate so as to find the best one to book.

Many researchers in intelligent agents domain have focus on the design of market architectures for electronic commerce [12, 15, 10]. In this paper, we use our proposed framework of Internet Marketplaces in [12,15] as the platform of electronic commerce. This framework simulates the real activities of customers and merchants, and facilitates parallel computing. The latter is especially important as more sites/shops can be searched in a shorter time to provide customers with better choices in their decision-making. The mobile agent based framework extends the traditional client/server architecture, which are widely adopted by current most e-shops and logically it is transparent to end-users.

The rest of the paper is organized as follows: Section 2 briefly introduces the infrastructure for Internet Marketplaces. Section 3 describes the 2-phase evaluation model and Section 4 presents an example to illustrate this model. Section 5 concludes this paper.

2. Infrastructure for Internet marketplaces

In this section, we first briefly introduce the mobile agent based infrastructure for Internet Marketplaces that enables parallel processing.

In this framework, there exists a set of marketplaces (see Figure 1). They are connected to the Internet. The Mobile Agent Service Provider (MASP) is an execution environment for mobile agents. A consumer-agent can be created at MASP at the client's request. Such a consumer-agent can reside in the MASP, act as a master agent and dispatch its worker agents to related marketplaces (MP) to fulfill the tasks. There also exists a set of Marketplace Community Service Servers (MCSS). A MCSS is responsible for maintaining the information of MPs and e-shops in the MPs.

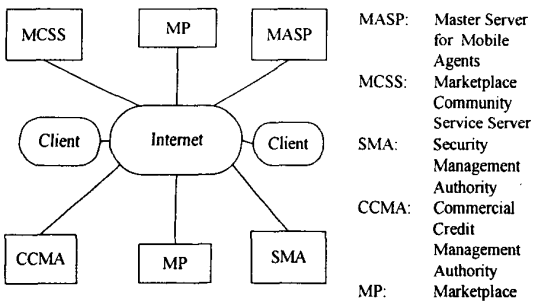

Figure 1 Overview of the Marketplace

2.1 System components

2.1.1 MCSS (Marketplace Community Service Server)

A MCSS is responsible for maintaining the information of MPs. The information should include the domain names, IP addresses of MPs and e-shops, goods catalogue, and the IDs of the MPM (MP Manager) and shop-agents running at each MP. The information of related MPs and e-shops can be provided when a client tells the MCSS the kind of goods it needs. When only a few MPs are set up, one MCSS can be set up for the serving. When more MPs are set up, a set of MCSSs should be distributed in different zones.

2.1.2 MASP (Mobile Agent Service Provider)

MASP is a server provided to registered consumers to create consumer-agents at the requests from clients to search for information of one or more specified goods. With the client's searching criteria, the consumer-agent will dispatch in parallel a pool of mobile agents to relevant e-shops, which will return the queried results.

2.1.3 SMA (Security Management Authority)

SMA is responsible for generating certificates for all MPs, e-shops and MASPs, and managing them. In addition, SMA is responsible for making security assessment on those authorized hosts according to attack reports and periodically reporting the update of security ranks of MPs and e-shops to the MCSS. Here a host denotes the MP-Server or E-shop server where mobile agents can be dispatched. For more details please refer to [12].

2.1.4 CCMA (Commercial Credit Management Authority)

CCMA is the authority making commercial credit assessment and management over all e-shops. When merchant cheating occurs, a client can report it to CCMA. After investigation, the commercial credit of the e-shop will be downgraded. On the other hand, successful transactions will help to upgrade the commercial credit.

2.1.5 Client

A client should be a registered user of any MASP before utilizing the facility of the MASP based on mobile agents. It can

(1) Search specified goods through the service based on mobile agents from the MASP till making the payment.

(2) Appeal to the CCMA for any merchant cheating that may occur during the purchase and can hardly be detected before payment. If the cheating is true, the merchant's commercial credibility will be degraded. This will result in fewer consumer-agents being dispatched there.

2.1.6 MP components

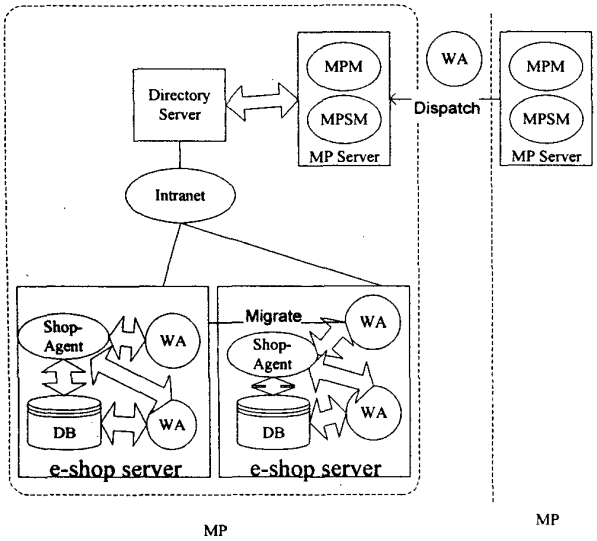

Figure 2 MP components

A MP is the Internet marketplace consisting of a set of e-shops that run simultaneously on different servers (see Figure 2). Within each MP, it has the facility to accept registrations of e-shops, maintain a directory of them, and authenticate foreign mobile agents.

The components of a MP is presented as follows:

1. **MPSM** (MP Security Manager): MPSM is similar to the firewall of an intranet. It is in charge of
   (1) Maintaining the security of the whole MP, such as authenticating coming foreign mobile agents and monitoring the communication out of the MP from a mobile agent or an e-shop
   (2) Broadcasting the certificates of e-shops to other relevant sites, such as MASPs
   (3) Registering the MP to MCSS.
2. **MPM** (MP Manager): A MPM is responsible for the management of the MP, such as accepting the registration of an e-shop in the MP and the application of withdrawal, and maintaining the directory of e-shops in the MPDS directory server (MP Directory Server).
3. **MP-Server**: It is a server where MPSM and MPM run. It is also an execution environment for incoming mobile agents. An agent dispatched by a master consumer-agent for visiting e-shops in the MP will first arrive here. Only after having passed through the security check by MPSM, it can enter any e-shops in the MP.
4. **Shop-Agent**: A Shop-Agent is an agent running at the shop server that is responsible for
   (1) Maintaining the shop information and goods information stored in the shop database.
   (2) Periodically send updated information to MPM for modifying the goods-catalogue of the e-shop maintained in the MPDS (MP Directory Server).
   (3) Communicating with incoming consumer-agents providing the goods information they required.
   (4) Monitoring the execution of foreign consumer-agents and protect the local resources of the e-shop
   (5) Registering the e-shop to the MPM and through it register to the MCSS when the e-shop is set up
   (6) Applying the certificate of the e-shop from SMA and send it to the MPM
5. **MPDS** (MP Directory Server): Its responsibility is to store the registration information and the goods catalogue information of all e-shops in the MP. Only the MPM can update and maintain them.
6. **E-shop Server**: An e-shop server is the place where the e-shop is set up within the domain of a MP and the shop-agent runs. It is also the execution environment of incoming mobile agents.

2.2 Process workflow

Based on this framework, the process enabling buying and selling can be described as follows:

1. Input Request: A client selects a MCSS where he/she has registered as a user to input the information of a good such as the name, model, type, some selection criteria for the goods such as the warrantee service and delivery/shipment service, and potential merchants, such as the security rank and commercial credit.
2. First-phase Evaluation and Searching E-shops: With the request of a client, a consumer-agent is created at the server of the MASP, who will act as a master agent and dispatch in parallel a pool of mobile agents, which are termed as worker agents (WA) and Primary Worker Agents (PWA). These agents will be tasked to visit qualified e-shops. For more details of the secure parallel dispatch model please refer to [16, 17]. An e-shop is selected only if its security rank, commercial credit and delivery/shipment services meet some requirements specified by users. These attributes are obtained from MCSS, SMA and CCMA.
3. Second-phase Evaluation: With the results returned by all mobile agents, the second phase evaluation is taken on both goods' information and e-shops' security rank and commercial credit. The sorted results are presented to the client by the master consumer-agent.
4. Negotiation: With the client's selection, a few e-shops will be selected for negotiation by dispatching a negotiation-agent. A lot of negotiation models have been proposed, such as [5]. In this paper, we will not address this issue.
5. Book and Payment: With the success result of negotiation, one e-shop will be selected to book the goods and make an online secure payment.
6. Purchase Feedback from Consumers: After delivery/shipment, the consumer can evaluate the transaction or report the merchant cheating. The

commercial credit of shops will be modified based on the feedback from consumers.

In addition, during the whole process, based on this secure parallel dispatch model, when any attacks from malicious hosts are detected, the master agent at MASP will report to SMA and the security rank of corresponding e-shop will be degraded. This will cause the decrease of the number of mobile agents dispatched to the e-shop there since the first phase evaluation will be taken before any searching-agents to e-shops are dispatched.

3. 2-Phase evaluation model with fuzzy-set rules

In our framework, we can easily deploy mobile agents for parallel processing. When the master consumer-agent is created and running, it can get a list of e-shops from the MCSS that offer the goods that its client needs to buy. For the phase of searching and negotiating The master consumer-agent can act as a master consumer-agent and dispatch multiple worker consumer-agents to these e-shops for querying goods' information, such as the stock status and the price. Each work consumer-agent is responsible for visiting one e-shop. Once it fulfils its task, it sends the results to the master consumer-agent.

Suppose there are hundreds or thousands of shops on the web selling the same kind of goods. It is unnecessary and impossible for a consumer or even an agent to browse all of them. So it is quite necessary and reasonable for the consumer to find a way to evaluate these shops and get the best shops for further transaction. This evaluation process not only accords with the human behavior, but also can reduce the network burden. Also the number of offers may be several times of the number of shops since a shop may provide multiple offers to a consumer. The consumer should evaluate the offers and get some best of them to negotiate with the shops for further benefits. This 2-phase evaluation model explores the issues of allocating the best and most convenient shops to the consumers as well as evaluating and filtering the offers, and returning the best offers to the customers. These allocation and evaluation is based on a set of predefined selection criteria that are domain specific.

Also because most real-world situations can involve preferences and constraints that may be imprecisely defined, such as low price, high quality, short delivery/shipment time, and so on, and the common knowledge may be limited to the agent, the autonomous agents should have the ability to consider these incomplete and imprecisely information. In our evaluation model, we applied the fuzzy-set technologies that have the ability to naturally represent human conceptualization [13] and proceed incomplete and imprecise information. With these fuzzy-set rules, the evaluation results are more reasonable and accord with human behavior.

3.1 Related work

Evaluation is an important and inevitable process in e-commerce. The evaluation model is used in the phase of search as well as negotiation. There are many research activities focus on this domain.

Vogler [11] presents an architecture that allows mobile agents to autonomously and automatically negotiate with vendors about offers. The approach allows evaluating multiple attributes of an offer, such as price, warrantee or shipping fees. This approach is based on scoring functions, which operate much like decision guide [8].

Kwang's work [14] explores the problem of connecting buyer agents and seller agents. An algorithm that uses multiple criteria to match buyers and sellers based on pre-specified user profiles was devised. The process of matching and connecting buyers and sellers are based on a utility evaluation function and a filtering algorithm.

Kowalczyk and Faratin's work [6, 4] explore the issues that apply the fuzzy concept in the agent-aided e-commerce system. Kowalczyk presents a customable Fuzzy e-Negotiation Agents (FeNAs) system for limited common knowledge and imprecise preferences. The FeNAs use the principles of utility theory and fuzzy constraint-based reasoning to find a consensus that maximized the agent's utility. Faratin's work presents an algorithm for performing trade-offs for multi-dimensional goods. The algorithm uses the notion of fuzzy similarity to find negotiation solutions that are beneficial to both parties.

The above-mentioned works are not very suitable for the parallel processing environment or not accord with consumer behavior.

1. Only the attributes correlated to the goods are evaluated in these works. But in real-life, the consumers consider not only the quality of the offer, such as price, delivery/shipment time and warrantee, but also the reputation of the shops. In general, they trend to choose shops with high commercial credit and good reputation.

2. These evaluation models are fully based on the pre-defined evaluation standard and user specified selection criteria. But indeed, the user maybe has limited common knowledge and the situation of the market maybe varies. With these pre-defined standard, the user may miss some better choices.

3. In some sense, the evaluation result is not very reasonable to the user. Because most real-world problem can involve imprecisely defined preferences and constraints. For example, one prefers to pay $1000 but it is no difference for him to pay $1005 or $995 (the difference is less than 1%).

4. In real world, the information the consumer can get is always insufficient. It is quite difficult for the consumer

to define the evaluation standard precisely based on such insufficient information.

In this study, we combine the advantage of above-mentioned works and present a 2-phase evaluation model with fuzzy-set rules. This model has several features and advantages as follows:

1. The evaluation process consists of two phases: shop evaluation phase and offer evaluation phase. The second phase is processed based on the result of the first one. This mechanism can reduce the network load and it is suitable for the environment that the computing resource is limited.

2. With the fuzzy-set rules and grading function, the agent can evaluate the shops and offers based on the real-time situation. The evaluation results accord with real condition and human conception.

3.2 Fuzzy-set rules model

In this section, we first introduce the basic conception of fuzzy-set rules.

A fuzzy-set rules model consists of a collection of rules of this form [13]:

If V_1 is A_{i1}, V_2 is A_{i2}, ..., V_n is A_{in}, then U is B_i.

The V_i's are the *antecedent variables* and U is the *consequent variable*. The A_{ij}'s and B_i's are fuzzy subsets over the corresponding variable's domain; generally, these subsets represent linguistic values.

The fuzzy-set rules model determines the consequent variable U's value for a given manifestation of the antecedent variables A_{ij}. This model uses the principle of utility theory and fuzzy-set rules. Such a model is straightforward and simple.

Assume a value x is consist of a number of attributes:

$$x = \{x_1, x_2, ..., x_n\} \qquad (1)$$

1. For each attribute x_i, calculate its firing level as:

$$A_i = F_i(x_i)$$

where F_i is the grading function for attribute x_i.

2. Calculate the scores of each attribute as:

$$U_i = V_i(A_i)$$

where V_i is the score function that maps the attribute score in the interval [1,10].

3. Calculate the overall utility of the value x as:

$$U(x) = \sum w_i U_i$$

where the relative importance that assigned to each attribute is modeled as a weight w_i. We assume the weights are normalized, i.e. $\sum w_i = 1$.

4. Calculate the overall firing level of the value x as:

$$U = F(U(x))$$

where F is the grading function for x.

So the rating function for a value $x = \{x_1, x_2, ..., x_n\}$ in the multi-dimensional space is defined as:

$$U = F(\sum_i w_i * V_i(F_i(x_i))) \qquad (2)$$

3.2.1 Grading function

Grading function is responsible for converting the attribute values into corresponding firing level. These levels are usually represented as linguistic values, such as very good, good, moderate, poor or very poor. These functions have several features as followed:

1. These functions are attribute dependent, i.e. for different attributes, there may exist different grade categories. In addition, for the attributes that can represent as digital values, i.e. price and delivery/shipment time, grading functions use these digital values directly; for the attributes that cannot represent as digital values directly, i.e. warranty time, there exist a table that maps these linguistic values into digital values.

2. These functions can either grade attribute values into pre-defined number of levels or grade them based on real-time market situation. In the first one, the user should specify the number of levels that he prefers. In the latter one, the agent summaries all the information it collects from the market and then generate the grading standards based on these information. These standards are dynamic and suitable for this transaction only.

3. Because the computing resource for an agent is limited, we use the k-means clustering algorithm for the first situation described above and simple clustering algorithm is adopted for the latter one.

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K-means Clustering Algorithm

Inputs: X_j ($j = 1...n$) // initial search result
k // number of levels

Outputs: Y_j ($j=1...k$) // clustering result

1. Select $X_{i1}, X_{i2}, ..., X_{ik}$ from X_i randomly
2. $Y_j = X_{ij}$ ($j=1...k$) // initial standard
3. Do until the group member is stable
   For each X_i ($i = 1...n$)
   If $X_i \in [Y_j, Y_{j-1}]$
   D_1 = Distance from X_i to Y_j
   D_2 = Distance from X_i to Y_{j-1}
   If $D_1 < D_2$ then X_i is in the clustering Y_j
   Else X_i is in the clustering Y_{j-1}
   Endif
   Endif
   Endfor
   Y_j = the average of cluster Y_j ($j=1...k$)
   EndDo

****

Simple Clustering Algorithm:

Inputs: X_j ($j = 1...n$) // initial search result
β // fuzzy factor

Outputs: Y_j ($j=1...n$) // clustering result

1. Sort X_j by ascent or descent to B_i
2. Grade_Level = 1 // current grade level
   $A = 1$ // the item number in current level

3. For each B_j (j = 2...n)

$$B^* = \frac{1}{A+1}\sum_{i=j-A}^{j} B_i$$

If $\frac{|B^* - B_j|}{B^*} > \beta$

Grade_Level = Grade_Level + 1

$A = 0$ // B_j is not in this level

Else

Y_j = Grade_Level

$A = A + 1$ // B_j is in this level

Endif

Endfor

****

3.2.2 Score function

The score function is responsible for mapping the attribute's firing levels into attribute scores in the interval of [1,10]. In this model, we use a linear score function of the following type:

$$U(A^*_i) = \frac{\max A^* - A^*_i}{\max A^* - \min A^*} \cdot 9 + 1 \qquad (3)$$

$$\text{or } U(A^*_i) = \frac{A^*_i - \min A^*}{\max A^* - \min A^*} \cdot 9 + 1 \qquad (4)$$

where A^*_i represents the average value of current level. Meanwhile we use equation (3) if the function is decreasing with respect to A^*_i and equation (4) if increasing.

3.3 2-Phase evaluation model

In this study, the 2-phase evaluation model is carried out in three stages: Input, Shop Evaluation and Offer Evaluation.

3.3.1 Input

In this phase, the master consumer-agent collects the consumer requests and consumer preferences from the consumer. The consumer requests can be grouped to "negotiable" requests and "non-negotiable" requests; the "non-negotiable" requests are used as query conditions in search phase while "negotiable" requests can be used in negotiation phase. The consumer should select the suitable rating standard predefined in the system or specify the consumer preferences by customizing the relative weight of each item. The consumer also needs to specify the selection criteria such as the number of shops/offers to be selected or the selection percentage. The master consumer-agent can evaluate shops and offers, and negotiate with vendors about the offers based on the consumer's preferences.

3.3.2 1st phase evaluation-shop evaluation

This phase explores the issues of allocating the best and most convenient shops to the consumers in electronic trading. Before dispatching worker agents, the evaluation is done only over several attributes such as the commercial credit, security rank, and delivery/shipment service.

The commercial credit of an e-shop is set based on the number of its previous successful transactions and e-shops with fast delivery/shipment and low expense will get high value for delivery/shipment service. Those attributes for the first-phase evaluation are stored in the MCSS with the goods types for all e-shops. After evaluation, worker agents will be dispatched to those qualified e-shops for searching in parallel. In this phase, the processes of allocating shops are carried out in three steps: Shop-Selection, Shop-Evaluation and Shop-Filtering.

Shop-Selection. In this step, the consumer-agent compares customers' requests from the e-shops' goods catalogs and get all correlated shops from MCSS.

Shop-Evaluation. In this step, the levels of shops are determined. This evaluation is based on the fuzzy-set model that uses the principle of utility theory and fuzzy-set rules. In our framework, the rating function is defined as follows:

$$U = F(\sum_i w_i * V_i(F_i(x_i))) \qquad x=\{C,S,D\} \qquad (5)$$

The value of x can be one of the following:

1) C means the commercial credit of the e-shop. E-shops with larger number of previous successful transactions and better feedback records receive a higher value of C. For every successful transaction, the shop will receive a number of credit points. Also the consumer can rate the products and service of the transaction. The shop can get additional credit points with the positive rating, or miss some credit points if the rating is negative. These information are maintained by CCMA.

2) S means the security rank of the e-shop. In our framework, SMA is responsible for making security assessment on those authorized e-shops according to attack reports and periodically reporting the update of security ranks of e-shops to MCSS. Higher security rank means higher security level for the shop.

3) D means the time for delivering the goods to consumers. The delivery/shipment time is quite important to a consumer. It maybe quite long if the consumer is far away from the location of the shop. So electronic shops should have specified geographical service scopes and only serve for the consumers in these areas.

In our framework, each shop has a table to illustrate the time for delivering the goods from the shop to consumers, such as Table 1.

Table 1 Service scope

Area	*A1*	*A2*	*A3*	Other
Time (days)	1	1	2	NA

Table 1 illustrates the delivery/shipment time of shop *XYZ*. The time to deliver/ship goods to area *A1*, *A2* is 1 day, to area *A3* is 2 days. This table means shop *XYZ* only serves for consumers from *A1*, *A2* and *A3*. If the consumer is from the area that the shop doesn't support, the *D* value will be set to 0.

Shop-Filtering. In this step, a number of shops are returned to the user based on the evaluation results and selection criteria that the consumer specified. The selected shops must fulfill three selection criteria as follows:

I) The shop that is active.

II) The shop in higher level.

III) The shop that the *D* value is not 0.

Criteria I) ensures that the e-shop is open. Criteria ii) ensures that the shop is "better" than the shops that are not selected. While criteria iii) ensures that the consumer is in the service area of the shop.

In the end of the first phase evaluation, a number of e-shops are returned to the consumer. The consumer can select some/all of the shops in the result for browse.

3.3.3 2nd phase evaluation-offer evaluation

In the offer evaluation phase, when all worker consumer-agents send back addition details of the goods, such as the price, stock status, warranty service, or the processing time is up, the evaluation process will be conducted again over all attributes and the sorted results will be presented to the end user. With his/her selection, the master consumer-agent can send new worker consumer-agents to a small set of visited e-shops to negotiate for lower price or more convenient services. According to the results, the end user will choose one e-shop for booking and payment.

The offer evaluation phase is similar to the shop evaluation stage. In this study, the processes of offer evaluation are carried out in two steps: Offer-Evaluation and Offer-Filtering.

Offer-Evaluation. In this step, the levels of offers are determined. In our framework, the rating function is defined as follows:

$$U = F(\sum_i w_i * V_i(F_i(x_i))) \quad x=\{P,D,W,C\} \qquad (6)$$

The value of x can be one of the following:

- P means the price of the goods
- D means the time for delivering the goods to the consumer
- W means the warranty time
- C means the commercial credit of the shop

We also defined several rating standards with different weight allocation. Users can either use these predefined rating standards or customize the weight of each item. There are four rating standard groups as followed:

- **Price Priority Standard Group**. If the consumer takes the price as the most important item, he may select rating standards in this group. In this group, the price gets higher weight than any other attributes. The offer with lower price may get higher score. There are three level standards in this group: *relative price priority*, *moderate price priority* and *extreme price priority* that the relative weight of price increased respectively.
- **Time Priority Standard Group.** If the consumer wants to get the goods as soon as possible, then the delivery/shipment time is the most important item for him. The offer with shorter delivery/shipment time may get higher score. There are three level standards in this group: *relative time priority*, *moderate time priority* and *extreme time priority*.
- **Service Priority Standard Group.** In this group, consumer prefers longer warranty time and better service. This group is suitable for the customers who want more warrantee and security. There are also three level standards in this group: *relative service priority*, *moderate service priority* and *extreme service priority*.
- **Balance Priority Standard Group.** In this group, consumer has no explicit preference. The weights of different attributes are similar.

Offer-Filtering. In this step, all sorted offers are returned to the consumer based on the evaluation result. The consumer can select some/all of the offers and negotiate with vendors about these offers for further benefit.

4. An example

To illustrate the evaluation model clearly, we present an example in this section.

Suppose a consumer wants to buy a laptop. He sets price and delivery/shipment time as "negotiable" requests and other attributes as "non-negotiable" requests. And he prefers lower price than any other attributes, so he selects moderate price priority as his rating standard. The consumer requests are shown as follows. The filter ratio *Top 30%* means that he only wants top 30% of the shops fetched back.

Product:	*Laptop*
Manufacture:	*Toshiba*
Model:	*Satellite 3000*
Price:	*$2500*
Warrantee:	*3 year international*
Delivery/Shipment Time:	*3 days*
Rating Standard:	*Moderate price priority*
Filter Ratio:	*Top 30%*

4.1 Shop evaluation

In this phase, the worker consumer-agent evaluates the e-shops; this evaluation is done only over several attributes that associate with the shops but not single

goods, such as commercial credit, security rank and delivery/shipment service. The consumer can set the number of shops he will browse or only set the percentage of the shops to be selected, i.e. he can select first 100 or top 30% shops and dispatch worker agents to these selected shops.

Suppose the worker consumer-agent get a list from MCSS with 300 shops that sell the product that the consumer requires. After shop evaluation, the consumer selects top 30% of the shops with better commercial credit, higher security rank and delivery/shipment ability in the area in which the consumer lives. Then the master consumer-agent sends worker consumer-agents to these shops to get detailed information. The evaluation results are shown in Table 2.

Table 2 Shop evaluation result

Shop No.	Comm-ercial Credit	Secur-ity Level	Delivery/ Shipment Time (days)	Evalua-tion Result	Select-ion Result
1	I	I	1	I	OK
...	...	...	...	...	...
40	I	II	7	II	OK
...	...	...	...	...	...
89	II	II	7	III	OK
90	I	II	15	III	OK
91	II	I	8	III	OK
92	I	III	3	III	OK
93	II	III	7	IV	NO
...	...	...	...	...	...
200	V	IV	7	VI	NO
201	V	IV	NA	VII	NO
...	...	...	...	...	...

Also, the selection results are generated based on the evaluation results and selection criteria that the consumer specified. In this example, the selection results are not restricted within top 90 shops (300*30%). All the shops that have the same evaluation results with No.90 (Level III) are also selected. This mechanism also accord with human behavior because these offers are same to the consumer.

4.2 Offer evaluation

Suppose half of the selected 90 shops give the consumer more than one offer. So the consumer at least get 135 offers now. It is impossible and unnecessary for the consumer to negotiate all these offers. The consumer should select best of the offers and negotiate these offers with the vendors for further benefits.

To illustrate the evaluation clearly and simply, we use an example with only 15 offers. The fuzzy factor β in simple clustering are set [1%, 20%] and the levels number k is set [5, 3] for the two attributes. To compare the evaluation result, we also use the linear rating function that is the same as the scoring equation (3) and (4) in Section 3.2.2. The evaluation results are shown in Table 3.

Table 3 Evaluation result

Offer	(price, delivery /shipment time)	Simple clustering (β= 1%, 20%)		K_means clustering (k=5, 3)		Line-ar ratin g
1	(990, 2)	I,II	I	I,I	I	9.8
2	(995, 3)	I,III	I	I,I	I	9.45
3	(1000, 1)	I,I	I	I,I	I	9.7
4	(1050, 1)	III,I	I	II,I	I	8.2
5	(999, 14)	I,VI	II	I,III	I	8.25
6	(1010, 15)	II,VI	II	I,III	I	6.7
7	(1080, 15)	IV,VI	II	III,III	II	4.6
8	(1090, 15)	IV,VI	II	III,III	II	4.3
9	(1095, 8)	IV,V	II	III,II	II	5.5
10	(1100, 7)	IV,IV	II	III,II	III	5.54
11	(1150, 7)	VI,IV	II	IV,II	III	4.04
12	(1110, 7)	V,IV	III	III,II	III	5.24
13	(1180, 1)	VII,I	III	V,I	III	3.3
14	(1190, 6)	VII,IV	III	V,II	III	3
15	(1200, 1)	VII,I	III	V,I	III	3.7

The evaluation results are generated based on the real-time marketplace situation and graded into several levels. We can find that these results are more reasonable and accord with human behavior with the fuzzy-set rules. The offers in same level have no difference to the consumer. The consumer can select the shops in first level or first two level for further negotiation without specifying the shop number he need or the lowest satisfied rating score.

5. Conclusions and future work

In this paper we present a 2-phase evaluation model based on the Agent-mediated Internet Marketplaces. This model not only accords with consumer behaviors, but also makes the evaluation process more efficiently. It allows consumer-agent evaluating multiple attributes of shops and offers, getting the best and the most convenient ones to browse, evaluating and negotiating about the goods by considering additional services offered by the vendors. This 2-phase evaluation model can also help to reduce the network burden.

Now this model is only used to evaluate the shops and offers. In our future work, the similar approach will be also used in the negotiation phase in order to offer proposals and counterproposals from the consumer-agents and shop agents. We intend also to extend this model with learning capabilities. It is important in both the evaluation phase and the negotiation phase.

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