An Intelligent Multi Agent Framework for E-commerce Using Case Based Reasoning and Argumentation for Negotiation

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Abstract. A multi agent system is composed of a number of agents, communicating, collaborating, coordinating and negotiating with each other to solve a complex problem. The work discusses an intelligent multi agent system which can be used effectively in e-commerce. The agents work on behalf of the user, and help him in buying a product directly or through auction. Case based reasoning makes the system intelligent and help the agents to reach conclusions. The negotiation is done though argumentation. The communication between the agents is done through ACL, also specifying the required ontology. Implementation of the system is done in JADE.

Keywords: Multi agent systems, case based reasoning, negotiation, argumentation, ontology, ACL.

1 Introduction

With the expansion of the internet, e-commerce has also seen a rapid growth. To keep pace with its growth, it's necessary to use a multi agent system, which provides a promising field for the approach of agent and artificial intelligence technology[1]. Steps are being taken to automate ecommerce business processes. Agent technology is often claimed to be the best approach for automating online shopping transactions. Intelligent agents are reactive, proactive and have social ability. Agents should be intelligent enough to work on behalf of the user[2]. An ecommerce system can be best realized through a multi agent system. Nowadays, when there are a large number of sites available for online shopping, its really becoming very tough for the people to choose the desired product at the right price. A multi agent system will help the user in reducing his burden in finding out the right product at the right place.

Most of the papers dealing with multi agent e-commerce systems, create as many buyer agents as there are buyers and as many seller agents as there are products to be sold [3,4]. As the number of products increase, the seller agents also increase, making the system hard to realize in real time scenarios. Nowadays, there are thousands of products being sold on every e-commerce site. Creating a seller agent for each of the products is quite cumbersome. This paper proposes an approach to have one seller agent per each e-commerce site. The second issue dealt in this paper is to have one common portal for all the e-commerce sites instead of having one MAS for one

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e-commerce site. Such a common portal is designed using a multi agent knowledge management system.

A key problem with all the first generation e commerce systems is that they are too focussed on one aspect of the transaction i.e price [5]. In direct buying also, there are many factors that need to be concerned apart from the price. This paper talks about a multi modal search of the products, keeping many factors in mind like the quality, quantity, color, price etc. In the case of auctions, when faced with the need to reach agreement on a variety of issues, humans make use of negotiations. The same can be achieved by automated negotiations performed by a multi agent system.

This paper talks about a multi agent system for e-commerce that uses case based reasoning and argumentation based negotiation. The remainder of this paper is organized as follows: Section 2 provides background in the areas of multi agent systems, agent communication, case based reasoning, and argumentation based negotiation. Section 3 deals with the proposed architecture in detail. It also briefly describes the agent communication through ACL Section 4 deals with the partial implementation of the system in JADE. Section 5 deals with the results and observations. Section 6 concludes the paper and section 7 talks about the future work.

2 Related Work

In a multi agent system(MAS), the agents need to cooperate, coordinate with each other to performs tasks which are not possible by stand slone systems. For effective communication between the agents, three things are of utmost importance [6]:-

- Communication language
- Communication protocol and
- Shared ontology

The internet and advancements in the technologies have revolutionized the way in which business and commerce is conducted nowadays. A lot has changed since the traditional retail shops of brick and mortar to the electronic form of trade[7].

Lasheng Yu talks about a Multi-Agent Automated Intelligent Shopping System (MAISS), but the problem in this architecture is that there is one seller agent for each product[8]. As the number of products to be sold increases, the number of seller agents also increases. With the growth of internet, the e-commerce sites have also increased incredibly and with them the number of products sold. Its almost unrealistic to have so many seller agents.

CBR is a method of making use of past experience to solve newly encountered problems. The past experience is recorded in the case base[9]. Pierre De Loor talks about decision-making in autonomous agents in interactive simulations with the help of CBR [10].

Agents need to cooperate with each other in a multi agent system. Communication among agents and facilitators is typically achieved through an agent communication language, such as the Knowledge Query Manipulation Language (KQML) or FIPA Agent Communication language (ACL) [11]. The semantics of these ACLs have been defined in terms of conditions on the mental state of agents which is supposed to have beliefs, intentions and so on [12,13].

Various interaction and decision mechanisms for automated negotiation have been proposed and studied. These include game-theoretic analysis [14, 15],heuristic-based approaches[16]andargumentation-based approaches[17]. In this paper, argumentation-based approach is discussed. as it allows more sophisticated form of interaction as compared to game-theoretic and heuristic approaches.

3 Architecture of the Proposed System

There are six stages of e-commerce as described by Pattie Maes et al [18]. The phases considered in this paper are depicted in the figure 1.

Fig. 1. Phases of e-commerce

The proposed multi agent knowledge management system for e-commerce has two modules- buy module and the auction module. The two modules are different because there are certain sites which do not have auction facility and there are some which do not have direct buy option. On the contrary there are some which fall into both categories, i.e depending upon the product, there are both options available of buying and auctioning. The working of both the modules is the same till the merchant brokering phase. The buy module doesn't have the negotiation phase. The flowchart of the system workflow can be depicted as in the figure 2.

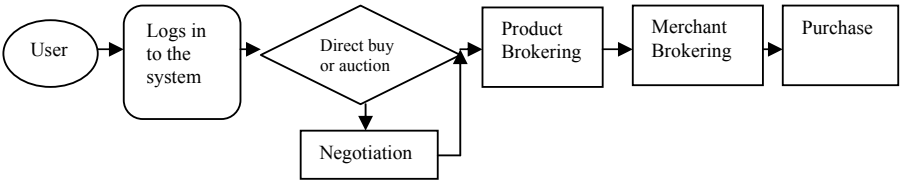


Fig. 2. E-commerce phases flowchart

3.1 Detailed Design of Buy Module

Buy module is the one in which there is no room for negotiation. Very few papers talk about this aspect. It happens many times that the user doesn't want to waste time in auctions or negotiations and want to purchase the item directly. In such cases its important to give the best possible results from all the sites to the user, and then he may decide amongst them.

Whenever a person attempts to buy a product, there are certain measures which helps him to decide to buy the product like price, quantity, quality, delivery area, delivery charges, time taken for delivery etc. All these factors well help to decide the site from which the product is to be purchased. Thus there will be a multi modal search by the system.The architecture of the buy module is depicted in the figure below

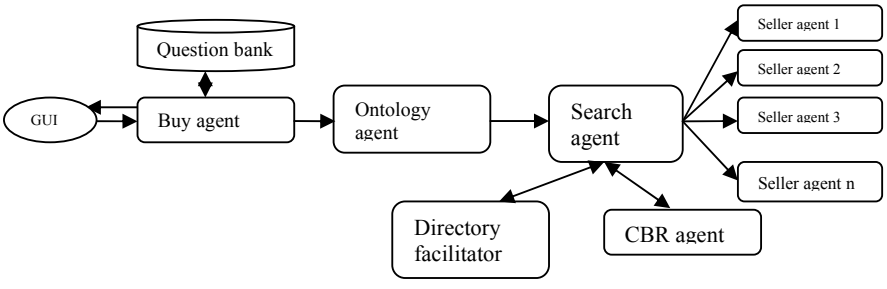


Fig. 3. Buy module

3.1.1 Product Brokering and Merchant Brokering

Product brokering is the method of selection of a product that suits the needs of the customer. Merchant brokering phase is almost automated with the help of an intelligent multi agent system. The agent on behaf of the user decides the merchant/ seller from which the product is to be bought. The merchant is an ecommerce site selling a product as identified by the product identification and product brokering phases.The buyer agent maintains a database of the different products classified into proper headings like Men, Women, Kids, Home and travel, Gift ideas and Fragrances and beauty. Then apparels, jewellery etc inside Women's category. Now, when one of the sub-category is chosen, the user is given sub-sub category. E.g. Men's apparel can be further sub-divided as Shirts,Trousers, Jeans t-shirts etc. Suppose the user chooses Jeans. This query is forwarded to the ontology agent. The responsibility of the ontology agent is to prepare ontology of the product as chosen by the user. If two agents are to communicate about some domain, then it is necessary for them to agree on the terminology that they use to describe this domain [19]. An ontology is a specification of a set of terms, intended to provide a common basis of understanding about some domain [19]. The description about the product should be common to both the buyer agent and the seller agents. There are three ontology languages that can be used, OWL, KIF and XML [19]. Here XML is used.

Now there may be a large number of sites selling jeans. There must be some other details as well which can help in filtering the results. It has a questionaire agent which asks questions from the user which helps it to decide the product from one specific site. This questionairre agent maintains a questionnaire bank,which is updated from time to time. There are specific questions for different products. For instance, in the above discussed case when the user is searching for jeans, the questions asked can be like Color of the jeans,Brand,Size,Regular fit /skinny fit/ slim fit,Low waiste/ high waiste,Delievry city etc.

The ontology would now look like

```
<catalogue>
    <Category name=”Men”>
        <Sub-category name=”Apparels”>
            < Sub-sub-category name=”Jeans”>
                <Brand>Levis</Brand>
                <Color>Blue<Color>
                <Delivery-date>10</Delivery-date>
                <Delivery-area>NCR</Delivery-area>
                <Size>30</Size>
                <Fit>Regular</Fit>
                <Price-range>1000-1500</Price-range>
            </Sub-sub-category>
        </Sub-category>
    </Category>
</catalogue>
```

This ontology is then transferred to the search agent. Search agent works on the principle of cooperative distributed problem solving (CDPS) [20]. Cooperation is necessary as no single agent has sufficient expertise for solving the problem of information retrieval. The agents in the search module share a common goal, and thus there is no potential for conflict between them. The search agent advertises the existence of the task to other agents in the search module with a task announcement, and then acts as the manager of that task for its duration.

Each agent corresponds to one of the e-commerce site registered with the directory facilitator (DF). The directory facilitator agent behaves like yellow pages. It contains the details of all the sites related to e-commerce. It’s necessary that the sites register themselves with the DF agent. The DF agent creates an agent for each subscribed e-commerce site and give them names like 1_seller_agent, 2_seller_agent etc. The search agent takes the information from the DF agent, and then sends the request for the product to the seller agents. It may issue a general broadcast to all the agents, or it can announce the task to some of the agents which it feels may solve its task. It takes the help of the case based reasoning (CBR) agent for this. CBR agent acquires knowledge about selling agents’ task solving capabilities by CBR and then the tasks can be assigned more directly without the broadcast of task announcements.

The CBR cycle consists of 4 phases namely Retrieve, Reuse, Revise and Retain. Since a problem is solved by recalling a previous experience suitable for solving the new problem, the case search and matching processes need to be both effective and reasonably time efficient.

The basic problem that arises is that of representation of knowledge in case base. If the representation is clear and crisp then the retrieval is efficient and less time consuming. The case base can be represented by using an ontology. Ontology based case based reasoning has been discussed by Yuh-Jen-Chen et al [21]. All the cases should be transferred into a standard format in order to solve the heterogeneous

problems. The CBR agent maintains a database of domain ontology and the case ontology. Whenever the search agent receives a query from the buy agent, it transfers this query to the CBR agent to find out a similar case which was solved earlier. If the CBR agent finds such cases/case, then that result is passed to the search agent, which may give the specific seller agent/s which was selected earlier to purchase a similar item. Thus the broadcast of task announcement is replaced by the task announcement to some specific few agents.

Only the case ontology is not sufficient because a case in one domain is different from the case in a different domain. So both the case ontology and domain ontology need to be matched by the CBR agent. During the Retain phase, useful experience is retained for future reuse, and the case base is updated by a new learned case, or by modification of some existing cases. Learning makes the case base expand quickly, which increases the search time a lot. To avoid this, there is a need to maintain the case base so that it doesn't become so large, that it becomes tough to manage. So, the unused cases need to be deleted. Or, instead of adding a new case every time, better to modify the existing similar case. There are many ways of case base maintenance. Here fuzzy logic is used in similarity measuring function to retrieve the similar cases. Fuzzy Similarity -measuring function is defined as follows [22].

$$\text{Similarity}(T_1,T_2)=\sum_{i=1}^{m}\sum_{j=1}^{n}\text{Dist}(A_{1i}:V_{1i},A_{2j}:V_{2j}) \quad (1)$$

where

$$T1: (A_{11}:V_{11},\ldots, A_{1m}:V_{1m}) \text{ and}$$
$$T2: (A_{11}:V_{11},\ldots,A_{1n}:V_{1n})$$
$$\text{Dist}(A_{1i}:V_{1i},A_{2j}:V_{2j})=W(A_{1i},A_{1j}) * \text{Equal}(V_{1i},V_{1j}) \quad (2)$$

The different seller agents listen to the task announcement and evaluate them with respect to their own specialized hardware and software resources. The seller agents compare the ontology given by the search agent with the product ontologies stored in their database. When any seller agent finds a match, then it submits a bid. A bid indicates the capabilities of the bidder that are relevant to the execution of the announced task. A bid may contain information like Price, Brand, Delivery date, Delivery area etc

The seller agents which didn't have an exact match between their product ontology and that of the search agent also place a bid. E.g. a seller agent selling a black jeans instead of blue jeans, also place a bid. The search agent analyses the bids and finds the perfect match. If it doesn't find a single perfect match, then it selects the agents which have bids with almost same properties of the product as the ones asked for. The selection is communicated to the successful bidders through an award message.

As depicted in the figure, 3 and 4 seller agents are chosen and the jeans sold by them are displayed to the user. The user can choose any one of them.

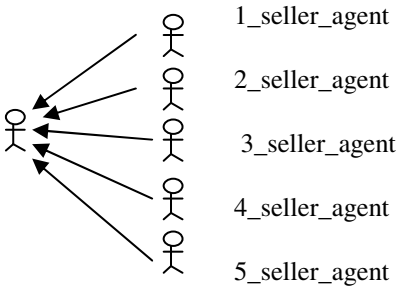


Fig. 4. Bidding

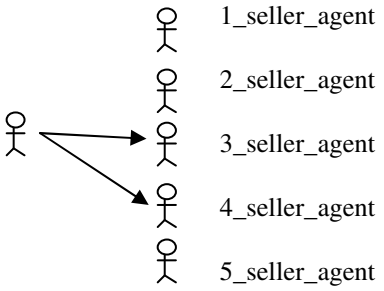


Fig. 5. Awarding

The search agent sends the results to the user. The user may select one of the selected agents. Then a direct link is formed between the user and the selected e-commerce site. The payment agent will next take care of the payments.

The buyer agent manages knowledge. It keeps track of all the orders placed by the user. It also keeps a check on the choices made by the user. E.g. the user prefers wearing a regular fit jeans, and then the system won't ask it from the user and will assume the choice of the user to be regular fir, although the user can edit his choice if he wants to. The same examples holds true with the size of the jeans. In such a way, the time of the user is saved and the system thrives to become intelligent. After every successful purchase, the feedback agent stores the feedback of the user. If the user is not happy with the products with one of the sites, then that site can be de-registered by the directory facilitator.

Once the selection is made by the user, the payment agent takes care of the payment made by the user. The payment should be completely secured using either MasterCard or Visa gateway. The information of the user is stored in a confidential database and cannot be showed to any other customer. The database stores the credit card number of the user, so that the user doesn't have to enter the 16 digits of its card again and again. For security reasons, the CVV number and the MasterCard or visa secure code will not be stored.

3.1.2 Communication between the Agents

There is a need of effective communication between the agents. The search agent needs to talk to the seller agents, the CBR agent needs to communicate with the search agent and so on. The communication language used in this paper is FIPA ACL which can be easily implemented in JADE. KQML message between the search agent and the seller agents is

```
ACLMessage msg = new ACLMessage(ACLMessage.cfp);
Jeans j = new Jeans
   ("levis","blue","7","NCR","30","Regular","1000-1500")
msg.addReceiver(new AID("Seller-agent", AID.ISLOCALNAME));
msg.setOntology("Product-ontology");
msg.setContentObject(j);
send(msg);
```

A “Jeans” object contains all the information that the search agent need to pass to the seller agents. The brand is levis, color blue, delivery date is within 7 days, delivery area is NCR, the size is 30, the fit is regular fit and the price range is 1000-1500.

This message is received by all the seller agents in the following format

```
ACLMessage msg = receive();
if (msg != null) {
// Process the message
}
```

3.2 Detailed Design of the Auction Module

As described earlier, e-commerce system has five phases. Negotiation phase is optional. In the case of negotiation, the ecommerce system goes through all the phases uptil merchant brokering. The only difference is that the DF agent will deal with only auction sites. The search agent will send the task announcement to them. Now the negotiation agent will start a negotiation with the selected seller agents.

(negotiation
(id auction-12)
(bid-increment 5)
(terminator-window 10min)
(highest-bid 1500)
(current-highest-bid 10))

The first four fields are constant and the last field will be updated regularly. This is the case when the negotiation is single modal, i.e the negotiation is on only one property i.e. the price. It may happen that the person is not ready to negotiate on price but it can negotiate on color or the delivery date. In that case, the framework becomes multi modal. Argumentations mainly include reward, threat and appeal[23]. The process of negotiation proceeds by the exchange of proposals, critiques and /explanations. A proposal is a kind of a solution to a problem that the agent has to solve. The search agent puts a proposal to the seller agents in the following format:-

A: I propose that you provide me a product X
The seller agent can respond in two ways:-

B: I accept	acceptance
Or B:I don’t have product X	reject

The first scenario is an Award when the search agents gives a reward message to the seller agent B.In the second case the search agent can recommend the product to the seller agent B and then it will be a Threat message. In addition to rejecting a proposal, the seller agent can offer a critique of the proposal, explaining why it is unacceptable.

E.g

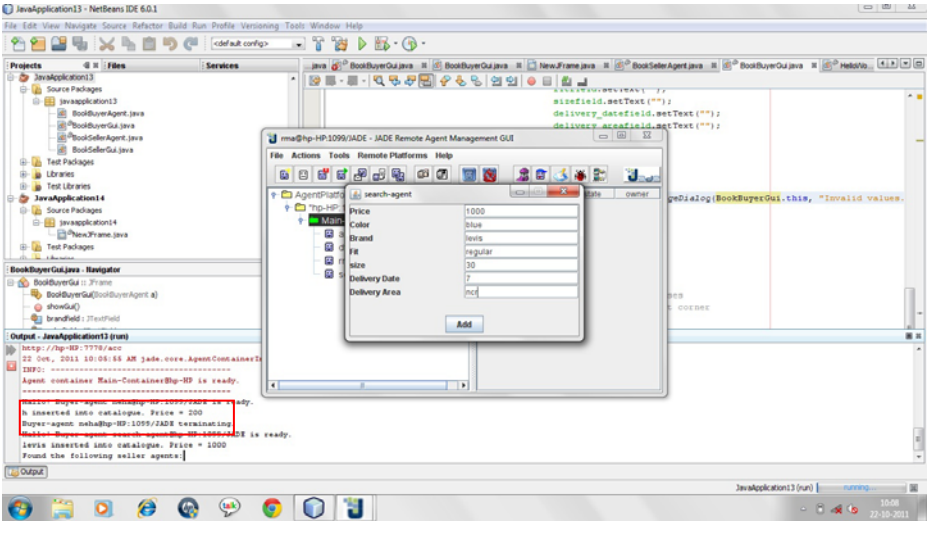
B: I can provide X, provided you change your choice to “Grey color” or

This scenario is an Appeal. Such a critique is important in the case of multi modal negotiations. Mathematically stated, when there are ‘m’ criteria and ‘n’ alternatives, there are k pairwise comparisons to run a full fuzzy analytical network process(FANP) solution[24]

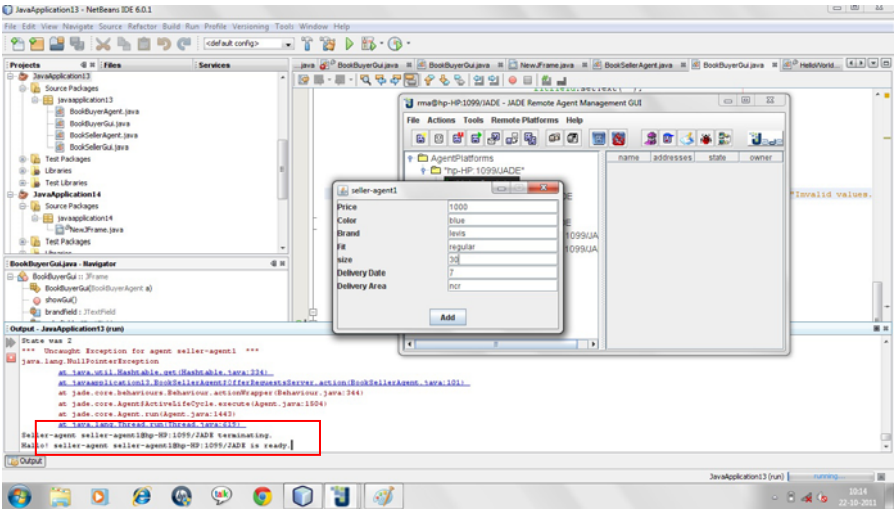
$$K= [(m*n (n-1)) /2]$$

4 Implementation

Once the architecture of the multi agent ecommerce system is ready, then its implementation can be done in JADE [25]. JADE is a middleware that facilitates the development of multi-agent systems. Due to time constraints, only the buy module has been implemented. The buy module consists of the search-agent and the seller-agent along with the directory facilitator agent and CBR agent helping the search agent in its operations. The screen shots show the buy agent taking options from the user. The user has selected to buy a jeans. The search agent contacted the questionnaire agent and came out with the specific questions to be asked to the user regarding the jeans.Once the search agent has the options, it adds the details to the catalogue.



The seller agent is created and the product that it sells is also entered.



Finally the product is brought from the seller agent with the help of purchase agent.

5 Results and Observations

As stated in the previous section, the proposed multi agent system was implemented in JADE. There were certain results and observations. They are as follows:-

1. The negotiation module considers ‘m’ criteria and ‘n’ alternatives and k pairwise comparisons, this makes the process quite comple. The time complexity also increases.
2. This system aims to give the desired product to the user, being selected from a number of sites registered with the directory facilitator agent. Generally, a user searches for a product on different sites separately. He may get the product, but will have to compromise on some or the other factor due to time contraints. But the proposed system searches for the product on all the sites available and give the best deal to the user.
3. There is a need of the e-commerce site to register to the directory facilitator agent so that the system can search the site for a product. This requires a third party subscription. The e-commerce site may be sceptical about its security and may be hesitant to subscribe. In that case convincing it for subscription can be tough. Moreover, some of the well established sites doesn’t want to have a third party subscription at all.
4. The product ontology needs to be stored with the seller agents. If there are some thousands of products, then such thousand ontologies need to be stored in a database attached to the seller agent. This may make the seller agent heavy and costly.

6 Conclusion

This paper discusses a multi agent system for ecommerce. The system incorporate a number of agents cooperating with each other using FIPA agent communication language i.e. ACL and sharing a common ontology. The agents help the user in buying a product directly or through auction. The auction is multi modal and is realized using argumentation. Case based reasoning is used so that the complexity of the system reduces. The time taken to display the results to the user, containing the list of sites selling the desired product; also reduces considerably. The system is implemented using Java Agent Development Environment (JADE).

7 Future Work

The future work corresponds to adding knowledge component in the model. The case retrieval from the database can be made more effective using knowledge retrieval and knowledge re-use. Right now it has been assumed in the buy module that the user is giving only single value for all the parameters. The future work will give more options to the user, i.e. he can enter more than one choice for a parameter. Secondly the negotiation module need to more cost and time effective. The negotiation between the agents should go on smoothly giving various options to the user. The auction module needs to be implemented in JADE.

References

1. Xu, B., Yu, Y.: Multi-agent Based Approach to Collaborative Shopping. IEEE (2010) 978-1-4244-7974-0110/$26.00 ©2010
2. Jain, P., Dahiya, D.: Architecture of a Library Management System Using Gaia Extended for Multi Agent Systems. In: Dua, S., Sahni, S., Goyal, D.P. (eds.) ICISTM 2011. CCIS, vol. 141, pp. 340–349. Springer, Heidelberg (2011)
3. Chavez, A., Maes, P.: Kasbah: An agent marketplace for buying and selling goods. In: Proceedings of the First International Conference on the Practical Application of Intelligent Agents and Multi-Agent Technology (PAAM 1996), London, UK, pp. 75–90 (1996)
4. Badica, C., Badita, A., Ganzha, M., Paprzycki, M.: Developing a Model Agentbased E-commerce System. In: Lu, J., et al. (eds.) E-Service Intelligence—Methodologies, Technologies and Applications, pp. 555–578. Springer, Berlin (2007)
5. Lomuscio, A., Wooldridge, M., Jennings, N.R.: A classification scheme for negotiation in electronic commerce. Internat. J. Group Decision and Negotiation 12(1), 31–56 (2003)
6. Peng, Y., Finin, T., Labrou, Y., Chu, B., Long, J., Tolone, W.J., Boughannam, A.: A multi-agent system for enterprise integration. In: Proc. of PAAM 1998, London, UK, pp. 155–169 (1998)
7. Ferreira, C., Goncalves, R., Babo, R.: Evaluating functionalities of eCommerce websites for emigrants. In: 6th Iberian Conference on Information Systems and Technologies, CISTI (2011)

8. Yu, L., Masabo, E., Tan, L., He, M.: Multi-Agent Automated Intelligent Shopping System (MAISS). In: The 9th International Conference for Young Computer Scientists. IEEE (2008) 978-0-7695-3398-8/08 $25.00 © 2008
9. Wan, W., Zhang, J., Wang, M.: A Multi-agent Negotiation Protocol based on Extended Case Based Reasoning. In: Fourth International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 2007) (2007) 0-7695-2874-0/07 $25.00 © 2007
10. De Loor, P., Bénard, R., Pierre, C.: Real-time Retrieval for Case-Based Reasoning in Interactive Multiagent-Based Simulations. Expert System with Applications (July 2011)
11. Jain, P., Dahiya, D.: Knowledge Management Systems Design using Extended Gaia. Paper Published in the International Journal of Computer Networks and Communications (IJCNC) 3(1), 140–152 (2011) ISSN 0975 – 2293 (Special Issue)
12. Bagherzadeh, J., Arun-Kumar, S.: Flexible Communication of Agents based on FIPA-ACL. Electronic Notes in Theoretical Computer Science 159, 23–39 (2006)
13. DiPippo, C., Fay-Wolfe, V., Nair, L., Hodys, E., Uvarov, O.: A real-time multi-agent system architecture for e-commerce applications. In: Intl. Symp. on Autonomous Decentralized Systems, pp. 357–364 (March 2001)
14. Rosenschein, J.S., Zlotkin, G.: Rules of Encounter: Designing Conventions for Automated Negotiation among Computers. MIT Press, Cambridge
15. Kraus, S.: Strategic Negotiation in Multi-Agent Environments. MIT Press, Cambridge (2001)
16. Fatima, S.S., Wooldridge, M., Jennings, N.R.: Multi-issue negotiation under time constraints. In: Proceedings of the First IJCAAMS: Part 1, Bologna, Italy, July 15-19 (2002), doi:10.1145/544741.544775
17. Kraus, S., Sycara, K., Evenchik, A.: Reaching agreements through argumentation: a logical model and implementation. Artificial Intelligence 104, 1–69 (1998)
18. Maes, P., Guttman, R.H., Moukas, A.G.: Agents That Buy and Sell. Communications of the ACM 42(3) (March 1999)
19. Wooldridge, M.: An introduction to multi agent systems. Wiley publications, ISBN 978-0-470-51946-2
20. Aamodt, A., Plaza, E.: Case-based reasoning: Foundational issues, methodological variations, and system approaches. AI Communications 7(1), 39–52 (1994)
21. Chen, Y.-J., Chen, Y.-M., Su, Y.-S.: An Ontology-Based Distributed Case-Based Reasoning for Virtual Enterprises. In: CISIS 2009 (2009) ISBN: 978-1-4244-3569-2
22. Wan, W., Zhang, J., Wang, M.: A Multi-agent Negotiation Protocol based on Extended Case Based Reasoning. In: FSKD 2007 (2007)
23. Dong, T.-T., Feng, Y.-Q.: An Argumentation-Based Negotiation System. In: 2010 3rd International Conference on Information Management, Innovation Management and Industrial Engineering (2010)
24. Ahmadi, K., Charkari, N.M.: Multi Agent based Hybrid E-negotiation System in E-commerce. IJIPM 2(2), 88–96 (2011)
25. Bellifemine, F., Caire, G., Greenwood, D.: Developing multi-agent systems with JADE. Wiley Series in Agent Technology (February 2007) ISBN 978-0-470-05747-6