

Intelligent Agents for Negotiation in Electronic Commerce using Fuzzy Logic and Genetic Algorithms

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ABSTRACT: - The growth of Electronic Commerce on the Internet it has carried to a greater interest in the research of agents software in order to automate and to render faster the negotiations in the chaotic on-line market. The objective of the mobile agents is that to eliminate the defects of the commerce on-line classic, maintaining some the advantages. We propose a new model of automatic negotiation based of Intelligent Agents which ago use of Fuzzy Logic and Genetic Algorithms in order to carry out transactions of goods and services based on the various demandes that could have a buyer or seller user.

Key-Words: - Electronic Commerce; Automatic Negotiation; Intelligent Agent; Fuzzy Logic; Genetic Algorithms

1 Introduction

The development and the natural spread of Internet have carried to the conception of new habits, styles, tendencies which have had a lot often the merit to simplify many of the operations that before we were forced to carry out personally. The most famous and promising of these it is sure the Electronic Commerce that it allows us to make purchases comfortably seated in front of ours personal computer. Even if in our Country the spread and above all I use it are still limits, it can be defined already old, at least in its use classic. This happend to the new technologies: the technological evolution travels therefore fast that often many solutions already are exceeded before still that they are diffuse on the market. To leaf through catalogues on-linens, to consult information on the products, to verify the aspect, to use virtual undercarriages of the expense and also to manage personally operations of payment and confirmation of order in real time they are all operations that between little time could more not be taken from we. Of the software agents [1] aware of our needs and preferences with negotiation ability, in a next future, they will help us to carry out these tasks, carrying out operations of search of the products, appraisal of requirement demands and dealing for the price to our place. An example of that is the so-called "Shopbots", that is more or less intelligent programs that cover in continuation the net to the search of the products of our interest, proposing some to us one comparative selection for the price/characteristics appraisal of the best relationship. The main problem is just how much can be intelligent this software, or better based on which parameters they will be able to decide if it is convenient for we to acquire a good or to decide to contract in order to try to obtain greater services and reductions in price on the price. Agent seller used by the vendor would have instead to be in a position to understanding if it is convenient to offer more services or to lower the price

ulteriorly so as to not to let to lost a possible customer, without but renouncing to just the margin of gain. Intelligent Agents [2] have been wide study in the artificial intelligent and in the multiagent systems [3,4]. An agent can on behalf act of a customer in independent way and cooperative with other agents in Internet, without that same user if she notices some. Therefore, as example, an agent buyer could mediate more simultaneously sellers, estimate their proposals and carry out one to select in order to leave we the choice to accept of more interesting offert between a much reduced number of chosen. There have been important studies on agent-mediated electronic commerce [5]. We can classify this research in two category: first category covers agent-based electronic markets (e.g. Kabash [8], Tete-A-Tete [9], FishMarket [10], eMediator [11], and AuctionBot [12]). Second category covers shopping information gathering agents [13,14,15,16,17].

Learnig ability it is the more important element of the Intelligent Agents; their acquired acquaintance will concur with ours personal agent to behave itself, more or less, as we in phase of search and negotiation of purchase of a good would make. In carrying out this task in the model from we proposed us comes in aid the Fuzzy Logic [6] that buyer to choose if it is convenient or not to buy a good, based on the proposed price and to the services will allow to a customer that us come offers; instead, from the other part, an seller agent uses this logic in order to mainly try to tempt buy, offering more services or diminishing the price. The acquaintance of ours objects from part of the agents will come acquired across Genetic Algorithms [7] through which, based on the various importance that seller and buyer gives several to the services, we will be able to go to determine the weights to attribute to parameters which guarantee, times of delivery, technical support etc. In the next sections we will analyze control system from we proposed, separately facing the point of view of buyer and

seller users, we will examine their politics in accepting and to propose a sale and as they will come used in this within the Fuzzy Logic and Genetic Algorithms.

2 Fuzzy Logic “like calculate with words”

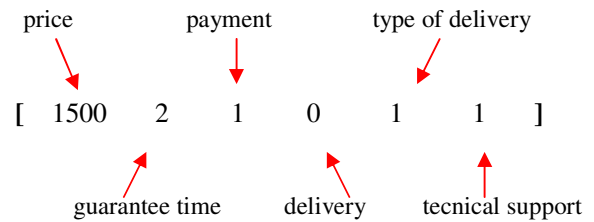
The total cover of Internet and the unavoidable spread of the connection to wide band have increased more and more the expectations tied to the Electronic Commerce, raising a new field of interest in the sale of goods and services, that negotiation on-line. Protagonists of these mediations are the Mobile Agents, which, operating in common platform, can unavoidably enter in conflict between they [18,19]. Negotiation has become then a predominant process in order to resolve conflicts. Some searcher have proposed own tactics of negotiation that express attitude begins them of agent and generates counterproposal in order to conclude buying and selling operations [20]. Our work previews just the interaction between two Intelligent Agents: an seller agent and a buyer agent. Scope of the two is the dealing on-line of goods and services to the aim to obtain the more favorable conditions for everyone than they. We put ourselves in the cloth of a user whom it wants to delegate just a software agent to purchase a home personal computer. We will concentrate on a particular case of purchase of a product, this will allow us better to examine the phase of negotiation between the two agents in detail, and to give a real range to input parameters. To purchase this type of product, usually seller offers precise services, that we can remark in the following table:

| service | type of service | quality |
|------------------|-------------------------|---------|
| guarantee times | two years | 2 |
| | one years | 1 |
| | only during transport | 0 |
| payment | only at delivery | 2 |
| | online with credit card | 1 |
| delivery | money transfrer | 0 |
| | in a week | 2 |
| | in 10-15 days | 1 |
| type of delivery | 1 month | 0 |
| | at home with expert | 2 |
| | at home | 1 |
| tecnical support | to retire at pop-it | 0 |
| | 24 hour at day | 2 |
| | online support | 1 |
| | no tecnical support | 0 |

We attribute to everyone of these services a value that allows us more easy than to judge of the quality:

- 0 → quality of the service poor or absent ;
- 1 → quality of the service acceptable;
- 2 → quality of the service excellent;

We think that these are extremely important parameters in order to define the validity of an offer even if in truth we can insert others parameters without to offend the validity of the solution proposed to the problem. We now give our attention before on the strategy of the buyer and finally on that one of the seller. Note of the two strategies are opposite , linked between they from relations of the game theory. To demand to ours buyer agent of the product chosen , or more seller agents will answer to us with the following structure of data:



The first value that appears is the price that comes to us proposed, followed from the value of the quality of the services represented in table. Through the weights attributed by the buyer agent to different services it mask this set of input data in a simple input of two single ones, price and the convenience of the services. This last value is not other that the executed fuzzification by buyer agent of the services, through of the weights attributed to every every service (you see part following on the Genetic Algorithms). That is doing in order to render the rules of control fuzzy system simple and immediate to comprise and to modify. Therefore the Fuzzy Logic controller that we proposed considers only two inputs: price, factor of primary importance in a sale, and a numerical value from 0 to 2, that it expresses the quality of the services that us come proposals. This last step is made through following the medium weighed mathematics:

$$Quality\ of\ service = \frac{\sum_{i=1}^5\ servizio_i * peso_i}{\sum_{i=1}^5\ peso_i} \rightarrow [1500\ 1.2]$$

Thanks of Fuzzy Logic ours buyer agent from this data decided which operations to complete. Through inference rules and considering the membership functions (you see Figure 1a, b, c), ours agent will try to carry the negotiation to its main objective and that is that one to obtain a low price and a greater part of the services. In fact agent will try to contract with seller a lowering of price if this is high, or a greater amount/quality of the services if those offers it do not satisfy. The fuzzy control system and membership functions of the buyer agent are those represented in Figure1:

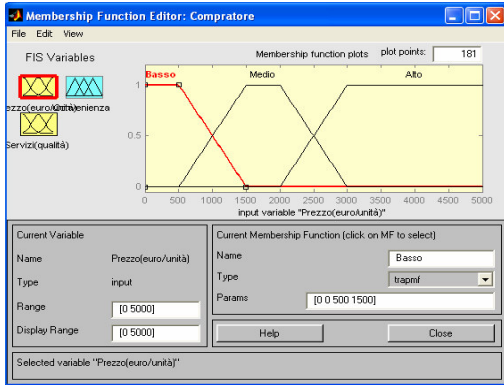


Figure 1a: MF Price (euro/unity)

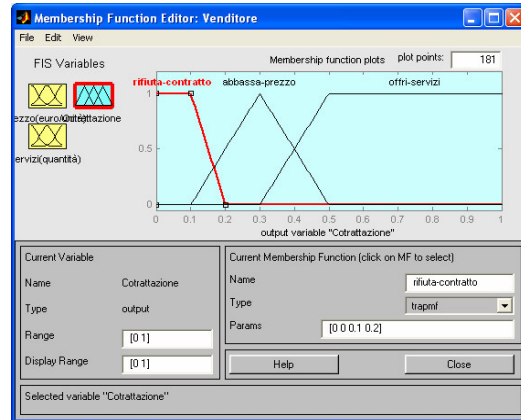


Figure 1d: MF Convenience buyer (%)

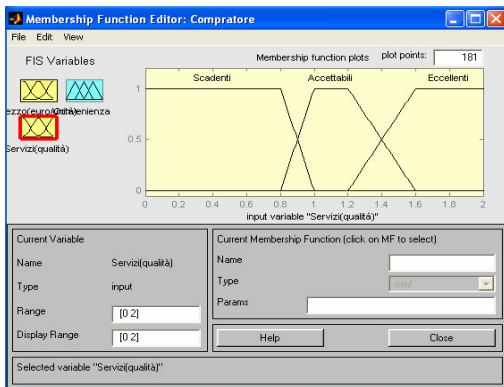


Figure 1b: MF Service (quality)

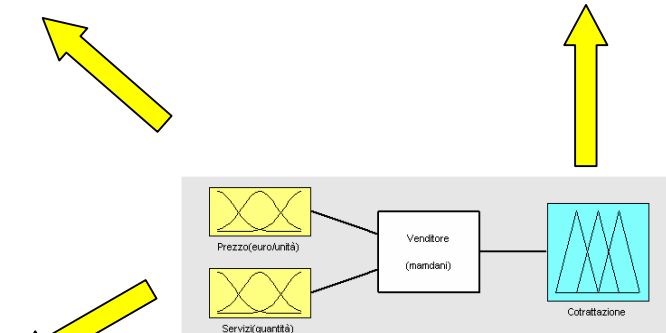


Figure 1 Buyer Agent

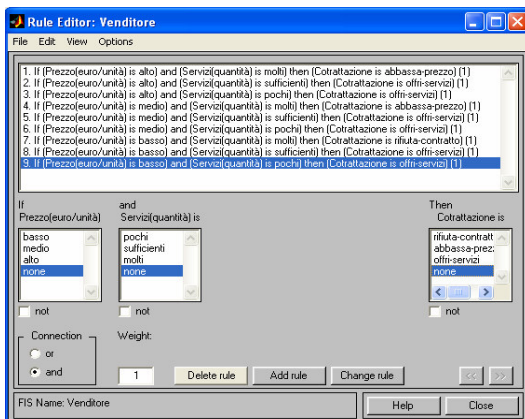


Figure 1c: rules of fuzzy inference system

The strategy of the seller agent is, like expecting, diametrically opposite to that one of the buyer agent : it initially proposes a price medio/high with to a reduced number of services. Only if buyer agent refuses the stipulation of the contract asking a contraction, it decides through the own rules of inference, if to offer ulterior services or to lower price. Model that we proposed of sell agent will always try to stipulate the contract offering services until when these are available; various he will be more prudent to lower the price, arriving also to refuse to continue a negotiation if it has already offered many services and price cannot diminish ulteriorly, cause eventual losses on just the margin of gain (you see Figure 2c on the rules fuzzy of sell agent). Also for the seller agent the services offered will have economic value, quantified through the attribution of opportune weights (see part on the Genetic Algorithms). The control fuzzy system and membership functions of the seller agent are represented in Figure 2:

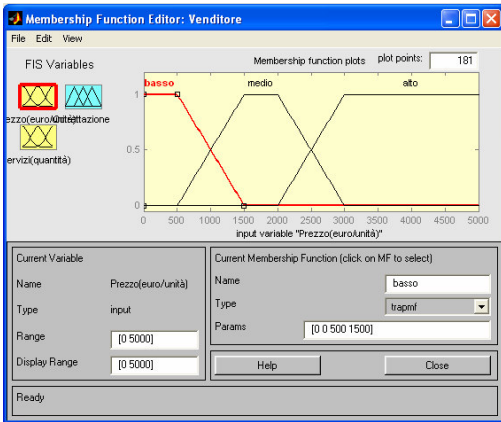


Figure 2a: MF Price (euro/unit)

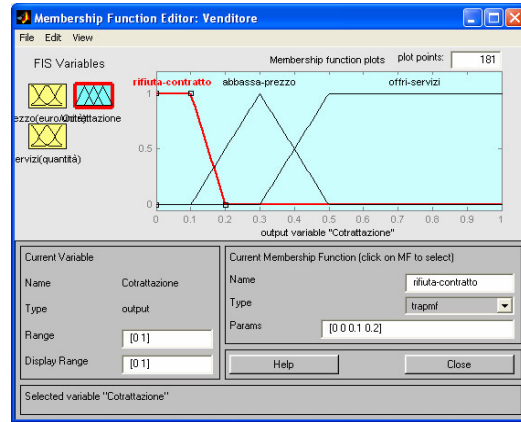


Figure 2d: MF Contraction of seller (%)

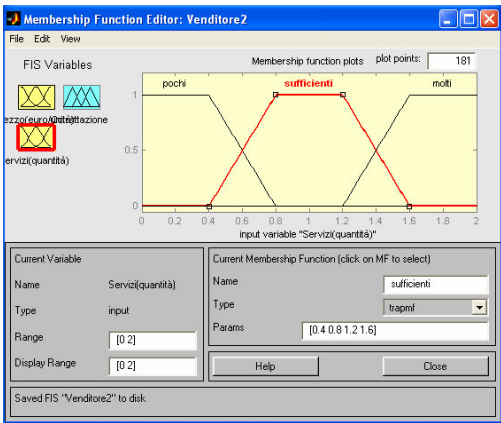


Figure 2b: MF Service

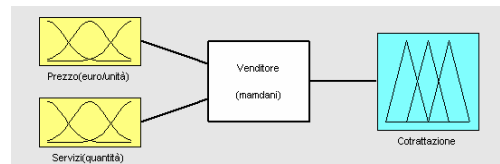


Figure 2: Seller Agent

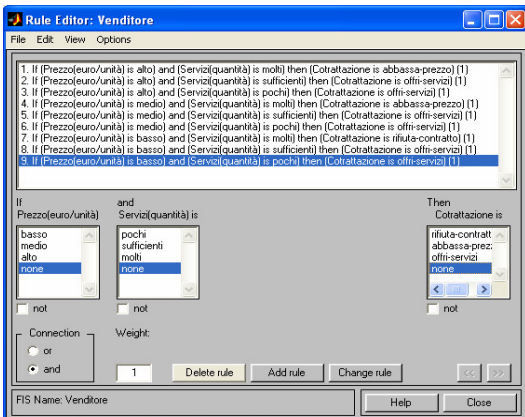


Figure 2c: Rules of fuzzy inference system

3 Genetic Algorithms: Genetic Variation and Natural Selection

The task of the two agents, beyond to interacting between of they for sale of a product, is fundamentally to be like we; they that is would have themselves to be involved as we would make really if we found ourselves in the same conditions of choice. The interaction between the two happens through a price and with of services proposals from the sender to the buyer and the successive chosen of buyer to accept the purchase proposal, to refuse it or to give to the way to one negotiation to the aim to obtain better advantages. The buyer agent will have to know as we in those same conditions will behave. To know this he must attribute a various weight to several the services, based on that they are our interests and/or needs. Also seller agent give a weight to the services that can offer; while but the weights attributed to the services from a buyer could be based on its personal interests, from the point of view of the seller these come attributed like effective price of the eventual offered service, that it will have to be curtailed from the margin of profit. We put ourselves as an example in the cloth of a user whom it wants to buy a personal computer. The services that in this case it can come offers are:

- Guarantee;
- Modality of payment;
- Times of delivery of the product;

- Modality of delivery ;
- Type of technical support.

The buyer could express the different importance that they give to these services for very different personal motivations. As a example, to buy a product on-line, buyer could give more importance to guarantee during the transport of the product and if possible the longer duration in terms of years of same guarantee. An other important parameter for ours buyer could be modality of payment: to pay to the delivery of product is more convenient that to carry out a payment on-line. It would better to have short times of delivery rather than long or uncertain much one. While the presence of a valid technical support (like as an example a service present green number 24 hours on 24) and delivery of the product directly to house, or in eventual POP-it where we go to take it personally, they could be seen like less important requirement of the others, but for this it does not have to hold of account in phase of chosen of purchase. In the cloth of seller they are just these services to which buyer give more importance, products at greater price; that involves that in the greater part of the cases the weights attributed from the two agents to the services turn out nearly to be similar, if not coinciding. Simply we will discuss this last case, but the modality to make to vary the weights, as it will be looked at later on, is much simple. The Genetic Algorithms are used in order to find the weights opportune to attribute to several services between “people” of eventual possible values. The first step to make in using this type of algorithm is to choose an opportune type of codifies to the data of our problem. We then decided to represent the weight of every service with a number comprised between 1 and 10 (that will be useful in the used mathematical equations later on). The more opportune choice in order to represent our weights will be that one to codify them in binary, through the use of 4 bit; we will have a number of 4 bit for every type of service and therefore a total of $4\text{bit} * 5\text{services} = 20$ bit. Then, considering now generic weights, ours ”element type” it will be constituted from “genetic code” following:

[Guarantee, Payment, Time of Delivery, Delivery, Technical Support]=[7 6 5 3 1]

it codifies in binary

[0111 0110 0101 0011 0001]

Also the importance that we give to the various services must be codified in binary; in order to do this we use of literary constraints as next example:

- 1)Guarantee duration has more importance or ugal importance of modality payment;
- 2)Guarantee duration has more importance, or same one, of time of delivery ,of type of delivery and of type of support;
- 3)Modality payment has equal or greater importance of type of payment and of presence of an eventual technical support;

Finally last constraint that is that all weights are between 1 and 10:

- 4) Every service must have a weight between 1 and 10.

These constraints make part of the genetic code that distinguishes every “individual/possibile solution” from the others and therefore also they will have to be codify in binary and added to bit string seen before. In order to make this we use symbol \geq in order to represent constraints and codify a generic one with value 1 if it is satisfied, or with value 0 in the opposite case. Constraints are:

- 1.Guarantee \geq Payment Modality
- 2.Guarantee \geq DeliveryTime+TypeDelivey+TecnicalSupport
- 3.Modality Payment \geq Type Delivery + Technical Support
4. $1 \leq$ Weight Service ≤ 10

With these 4 bit added string becomes (considering weights that we have seen before and verify that they are satisfied):

weights constraints

[0111 0110 0101 0011 0001 | 1011]

Successive step is that one of the choice of one oportune function of fitness. Scope of this last one is not other that to measure quality solution. We are using one codifies binary. So we can consider like function of fitness associating to every individual number of constraints that it satisfies. In order to make this we consider the Hamming distance only for set of constraints bit ; this is the different number of bit that two strings of same the “people” have. The “perfect individual ”, that is the optimal solution, will have last all four bit equal to 1, and therefore a function of fitness equal to 4 (random string that we have considered now have instead a function of fitness equal to 3). In order to improve solution we try to maximize this new value every generation of individuals. We will make to evolve our individuals from a generation to the next one through genetic operations that will have the task to modify the genetic patrimony of some individuals (individuals with function of fitness greater). Operations are of two types:

- **Cross-over**: from two strings, everyone composed from 20 genes, are generated two strings childrens, with an exchange of genes between the two parents: the first ten genes remain unchanged, while the others are exchanged with those of the other parent.
- **Mutation**: individuals that are in phase of mutation vary an accidental gene of own genetic code.

In order to make this we consider a threshold value $\alpha = 2$: individuals that will have a value of the own function of fitness greater of 2 evolves through operation of Cross-over; all others will evolves with operation of Mutation, so as to carry variety in the species.

3.1 Application of the Genetic Algorithms

The algorithm begins with a random population, i.e. weights chosen random, constituted from a hundred of individuals. These constitute our start population that evolves at every new generation, until generate an optimal solution. Generally the population comprises from 30 to 200 individuals, while the probability of Cross-over vary from 0.5 to 1 and that one of Mutation from 0.001 to 0.05. For criterion empiricist, suggested from experience, if population is small both the probabilities are small while if population is big both the probabilities are big. One function premlais to that is function of fitness for every individual; based on this value those most suitable ones to the reproduction come chosen, that it will come carried out through Cross-over, while remaining comes modified through Mutation. The process will have term in two possible cases: when we catch up a number of generations much elevating (but in this case we would have ourselves to be pleased of a solution that is approached that optimal one); or when last four bit of an individual are 1: this will be our perfect individual, that have weights goods.

Like example of application of Genetic Algorithms to our wor, we have obtained the following weights that they satisfy constraints imposed by the buyer:

[Guarantee,Payment,Time of Delivery,Delivery,Technical Support]=[10 6 5 3 1]

If we insert weights in table showing below, we can see which priority give buyer agent to the different estimate services:

| service | priority | type of service | quality |
|------------------|----------|-------------------------|---------|
| | | two years | 2 |
| guarantee times | 10 | one year | 1 |
| | | only during transport | 0 |
| | | only at delivery | 2 |
| payment | 6 | online with credit card | 1 |
| | | money transfrer | 0 |
| | | in a week | 2 |
| delivery | 5 | in 10-15 days | 1 |
| | | 1 month | 0 |
| | | at home with expert | 2 |
| type of delivery | 3 | at home | 1 |
| | | to retire at pop-it | 0 |
| | | 24 hour at day | 2 |
| tecnical support | 1 | online support | 1 |
| | | no tecnical support | 0 |

4 Example of Operation

We consider the weights finds previously and we see the negotiation between the two agents.

We suppose that the offer that it comes to us made from the seller agent is following: [2500 2 1 0 1 0]

Through the formula before this offer comes transformed in:
[2500 1.16]

Buyer software agent estimate this offer interesting, but not still valid in order to accept to buy the product, therefore decides to contract. Seller software agent has still services to offer and since the price is not very low, he answers offering other services. Initially he will offer those services with very low weight, waiting answer of buyer agent.

If after several negotiation new offert of seller agent will be:
[2500 2 1 2 2 2]

Through the formula before this offer are transformed in:
[2500 1.76]

Rules inference suggest to the buyer agent that this is a good transaction and therefore it give its approval for the purchase of personal the computer. This strategy could be used in order to make a list of all products that software agent estimate goods, and then to delegate directly user to take final decision.

5 Conclusions

Our work give a method of control for the negotiation and the sale of products and services applicable to the single case dealt here. As it has been looked at in phase of problem analysis, Fuzzy Logic is much flexible and concurs to widen the model to whichever type of negotiation. While the Genetic Algorithms concur to modify the weights attributed to the services in simple and fast way, through vague constraints directly expressed from the buyer/seller user to the own intelligent agent.

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