A Specialist Agent in Marketing Strategies for Quotes Establishment

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Abstract. The design and implementation of a specialist agent on market strategies are proposed under the rules of TAC-CAT agents International Contest. The main goal of this specialist agent is to create a market and then, to establish a set of policies in order to control agents' behavior who want to trade with him. One of the most important policies to obtain a profitable market is the quota policy, therefore a detailed explanation of the quota policy' strategies are provided. Finally, the results from tests on each strategy are shown.

Keywords: Electronic market, agents, TAC CAT, marketing strategies, economics.

1 Introduction

Along the time, the human being has had the necessity to negotiate diverse goods and services to satisfy its basic needs. Buyers and sellers are people who want to negotiate, they have to find a meeting point where they can negotiate, and this point is named market. Little by little well established big markets and informal small markets were appearing. Small markets being studied by Microeconomics usually trade with specific goods.

The concept of electronic market comes with the birth of the Internet. Electronic markets widely facilitate the negotiations between buyers and sellers groups. Agents are used to carry out these negotiations on Internet, which are entities capable of realizing autonomous tasks in an efficient way.

TAC CAT Market Design Agents International Competition [1] came out in 2007 as a TAC SCM [2] branch due to the exponential growing in electronic markets. In this tournament, the goal is that contenders make a specialist agent capable to create a market where buyers and sellers can negotiate under a set of rules that control agent's behavior, bids and transactions at the market.

This work shows design aspects and details of implementation of a specialist agent in market strategies based on TAC CAT contest. Policy of quotes receives special attention, since is one of the most important to guarantee a profitable market. Microeconomic theory' strategies are used to establish a quota policy, for which some test and results are provided.

Section 2 describes CAT game dynamics in a general way. In section 3, the design of the specialist agent in market strategies is discussed. A detailed explanation of the strategies used for the implementation of quotas policy is given in section 4. Section 5

Advances in Computer Science and Engineering.
Research in Computing Science 42, 2009, pp. 201-212

Received 09/03/09
Accepted 27/04/09
Final version 07/05/09

presents implementation of this policy. In Section 6 results of several tests are shown, and finally, the conclusions and ongoing work are presented.

2 TAC CAT: The Game

The CAT tournament is based on client–server model; Server performs the game on a JCAT platform [3]. The behavior of server and clients is regulated by CATP protocol [4]. CAT clients are represented on the platform as independent agents and they communicate among them through the server. CAT clients are buyers and sellers named negotiating agents, and specialist agents are the ones that represent the market.

Buyer and seller agents are provided by organizers of the contest. Each of them is provided with two strategies: a) market selection strategy and b) trading strategy [3]. Both strategies continuously change during the game and specialists do not know about them. Each negotiating agent has a set of private values (for trading goods) and a limited budget, both of them unknown as well.

Each contender designs and implements a specialist agent to create and control his own market, establishing the following policies:

Accepting policy. This policy judges whether a shout made by a trader should be accepted in the market.

Charging policy. This policy determines the quotes issued by markets which will be charged by the specialists (Figure 1(b)). These quotes are:

- Registry quote
- Information quote
- Shout quote
- Transaction quote
- Profit quote

Pricing policy. This policy determines the transaction price for matched ask-bid pairs.

Clearing policy. This policy determines how and when to clear the market, that is, how to match accepted shouts (matching function), and when to perform transactions over already matched shouts.

Specialists must register at CAT server before the beginning of the game, in order to establish a communication channel with the rest of agents in the game.

A CAT game lasts a certain number of virtual days. A day last a certain number of rounds and a round last a number of milliseconds. These data is announced by the CAT server to all of the clients before the game begins.

Before the game start, the Server freely offers the following information:

- Number of game days (NTD)
- Number of rounds per day(NR)
- Milliseconds per round
- Number of traders in the game (NTN)
- Number of specialists in the game (NTE)

At the beginning of the day, the specialist performs following activities:

- Establish policies
- Publish quotes

Along a trading day, the specialist must:

- Register traders
- Inform (to server or other traders)
- Analyze shouts
- Match shouts
- Execute transactions
- Charge quotes

At the end of the day, the specialist must obtain the following information to be sent to the server:

- Number of registered traders in its market (CN)
- Number of matching achieved in its market (NE)
- Number of transactions realized in its market (NT)
- Profit

When game ends some duties have to be performed, firstly each agent's score, such as CN, NE, NT, are summed out and a winner is declared according to the highest scoring.

3 Design: Architecture and Strategies

The architecture of the proposed specialist agent (named Tianuani) in market strategies is shown in Figure 1.

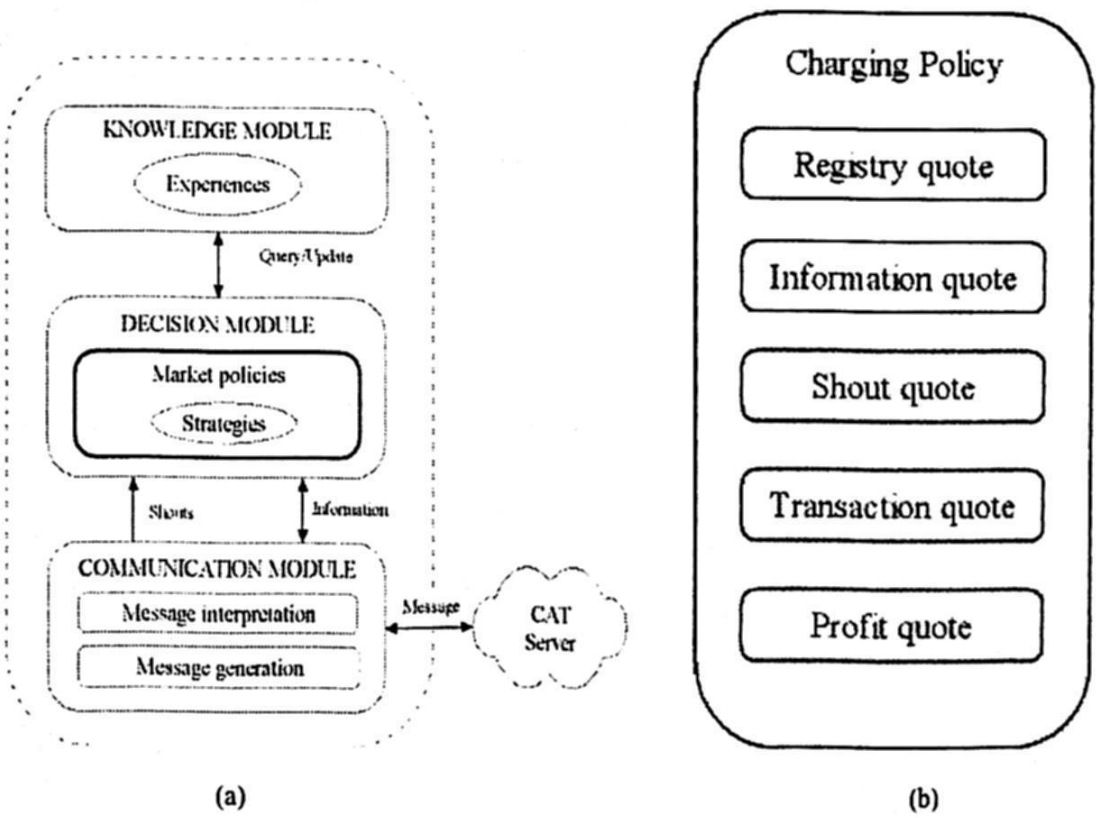

Figure 1. (a) Tianuani agent's architecture. This architecture comprises three main modules: knowledge, decision and communication [5]. (b) The charging policy. Quotes charged by the specialist.

Tianuani splits a trading day in three steps or states:

- Traders Capture State (TCS). Specialist begins the day in this state; this is the time when the traders pick its markets up. The goal of this phase is to get as much traders as possible.
- Profit Maximization State (PMS). After capturing a certain number of traders, specialist changes to EMU state, in which it tries to increase profit as much as possible.
- Transaction Maximization State (TMS). Once all transactions between the matched shouts with higher profits have done, then specialist changes to EMT, then it tries to match the higher number of shouts as possible no matter how much profit could be obtained.

Tianuani uses different strategies to establish these policies. Some of these strategies have already been tested in real stocks markets with human actors, and some others only represent theoretical models proposed by micro-economics researchers.

Based on which state the specialist is, it applies one of the next policies:

Accepting Policy. Use a combination of these strategies: *Self-beating accepting (AS)* [6] and *Equilibrium beating accepting (AE)* [7]. The paper [11] shows the design and implementation of this policy.

Charging Policy. Use a combination of these strategies: *Bait-and-switch charging (GB), Charge-cutting charging (GC)* [6] and *Learn-or-lure-fast charging (GL)* [8]. This police will be explained in more detail in the next section.

Clearing Policy. Clearing is done after each round is finished. For shout matching the following strategies were used: *Equilibrium matching (ME)* [9, 10] and *Max-volume matching (MV)* [6].

Pricing Policy. Use *Discriminatory k-pricing (PD)* [6] and *N-pricing (PN) strategies* [7]. The paper [11] shows the design and implementation of this policy.

4 Tianuani's Charging Policy

It is necessary to establish a right quota value, because that'd be charged in order to get a profitable market. This is not only for increasing the utilities but also for increasing the number of traders negotiating in it. In particular, trader agents provided by TAC CAT, posses market selection strategies oriented to the quotes analysis. In the Microeconomics literature, diverse strategies for this policy can be found, some of them are mentioned below:

- *Fixed charging (GF).* This strategy establishes quotes in a specific fixed level [7].
- *Bait-and-switch charging (GB).* In this strategy, the specialist modify its quotes when it capture a certain number of traders, and then it increases them

slowly in order to increases its profit. The quotes only get down whether the number of traders is below a certain threshold [7].

- *Charge-cutting charging (GC)*. This strategy establishes quotes based on the lowest charges imposed by the markets in previous days. *GC* is based on the fact of traders prefer markets with the lowest quotes [7].
- *Learn-or-lure-fast charging (GL)*. This strategy adapts quotes based on objectives, following the schema used by ZIP trade strategy [7].

Based on the above strategies, a combination of GC, GB and GL strategies is proposed to be used by the specialist according to its current state.

At the beginning of a trading day, specialist is in TCS state, establishing quotes, the starting quota represents the lowest value from the day before. Once a certain number of traders are captured by the specialist, it increases quotes inside of a predefine interval.

After leaving TCS state, the specialist increases slowly quotes based on defined intervals at PMS state. The goal here is, maximize as possible, profit from operations carried out in PMS state. These intervals delimit quotes increasing.

When specialist is in TMS state, quotes can be diminished in order to motivate traders to increase number of bids. The goal, in TMS state, is to maximize the number of transactions when the clearing policy is applied.

5 Strategies Implementation for Quote Policy

This policy determines the different quotes charged by specialists. A description and implementation of the algorithms for the quote charges are provided for each one in this section.

5.1 Registry Quote (CR)

Specialist charges a quote or fee when traders want to register in his market. The quote is a fixed fee previously established by the specialist. Three intervals based on the number of registered traders (C_N) are defined to control increment/decrement of this quote. The number of desirable traders (N_D) is given in expression (1).

$$N_D=|N_{TN}*0.70|/N_{TE}. \quad (1)$$

Where:

N_{TN}: Total number of traders in the game
N_{TE}: Total number of specialists in the game

Intervals are defined as follows:

Small register interval (*irp*): $C_N \in [0,0.25*N_D]$
Medium register interval (*irm*): $C_N \in [0.25*N_D, 0.5*N_D]$
Large register interval (*irg*): $C_N \in [0.5*N_D, N_D]$

Where 0.25 and 0.5 represents the percent of desirable traders

5.2 Information Quote (CI)

Traders and specialists agents can request information to any other specialist participating in the contest. A trader has to subscribe and pay an information fee in order to get information from a specialist (number of matchings, number of traders, number of transactions). The maximum number of subscribers N_{TS} *is defined in expression (2).*

$$N_{TS}=(N_{TN}-C_N)+(N_{TE}-1) \quad (2)$$

In the same way as for registry quote, three intervals based on the percent of subscribers (C_S) managed by the market are defined.

Small register interval (*isp*): $C_S \in [0, 0.25*N_{TS}]$
Medium register interval (*ism*): $C_S \in [0.25*N_{TS}, 0.5*N_{TS}]$
Large register interval (*isg*): $C_S \in [0.5*N_{TS}, N_{TS}]$

5.3 Shout Quote (CO)

When a specialist accepts a shout from a trader, a shout fee is charged to this trader. The number of shouts received during the day up to the moment (N_O), is calculated by the expression (3).

$$N_O=(N_E*2)+L_b.size+ L_a.size. \quad (3)$$

Where:

N_E Number of matching shouts
L_b: List of unmatched bids
L_a: List of unmatched asks
$L_b.size$: Size of L_b
$L_a.size$: Size of L_a

The minimum number of shouts (N_{MO}) is defined by the expression (4)

$$N_{MO}=|C_N*0.25|. \quad (4)$$

Number of shouts to be incremented (N_{IO}), by expression (5).

$$N_{IO}=|C_N*0.85|. \quad (5)$$

5.4 Profit Quote (CB)

Once a transaction is done, specialist charges a profit's percentage obtained by traders working in this transaction.

Buyer agent's profit in a transaction i (pr_{bi}) is calculated by expression (6).

$$pr_{bi}=|v_{bi} - P_T| \tag{6}$$

Where:

v_{bi}: Bid price on transaction i

P_T: Transaction price established by specialist

The seller profit in a transaction i (pr_{si}) is calculated by expression (7).

$$pr_{si}=| P_T - v_{si} | \tag{7}$$

Where:

V_{si}: Ask price on transaction i

The number of desirable matching (N_{ED}) is defined by expression (8).

$$N_{ED}=|C_N*0.85/2|. \tag{8}$$

Also, three variables are defined, based on the percent of desirable matching, for the profit quote increment

$N_{EB}=0.25$

$N_{EM}=0.5$

$N_{EA}=0.75$

5.5 Transaction Quote (CT)

When a bid is matched with an ask, Specialist charges this quote CT. The fee is calculated by expression (9).

$$CT=|CB*0.1| \tag{9}$$

5.6 Algorithms

Before a round starts method *Analize_Quotes()* is executed , establishing intervals for each quote.

Variables:
C_D←Days counter along the game
C_R←Round counters during the day
R_E←Number of rounds in TCS, calculated by expression (10).

$$R_E=|N_R*0.25| \tag{10}$$

Alg. 1. Operations for each round [11].

```
While (¡round_end)
    Register_trader()
    Register_subscriber()
    Shout_Analysis()
    Inform()
C_R=C_R+1
If (State=PMS) then
    Match_PMS()
Else if (State=TMS) then
    Match_TMS()
If {(State=TCS)&&[( C_N>= N_D)|| ( C_R>= R_E)]} then
    If (C_D=0) then
          State=TMS
    Else
          State=PMS
Analize_quotes()
```

Alg. 2. : Analize_quotes().

```
Analize_Quotes()
// Registry quote
    If (C_N∈irp) then C_R=0
    If (C_N∈irm) then C_R= C_R
    If (C_N∈irg) then C_R= C_R+0.1
    If (C_N >N_D) then C_R= C_R+0.5
//Information quote
    If (C_S∈isp) then CI=0
    If (C_S∈ism) then CI=CI+0.5
    If (C_S∈isg) then CI=CI+1
//Shout quote
    If (State=PMS) then
          If (N_O <=N_MO) then CO= 0
          If (N_O >=N_IO) then CO=CO+ 0.1
    If (State=TMS) then CO=0
//Profit quote
    If (N_E <N_ED) then CB= N_EB
    If (N_E =N_ED) then CB= N_EM
```

```
Else CB= N_EA
```

Algorithms 3 to 7 for charging each of the quotes are shown below.

Alg. 3. Charge for registry quote.

```
Charge_cr (trader)
    Send_message(trader,CR)
    Receive_message()
    Profit=Profit+CR
```

Alg. 4. Charge for Information quote

```
Charge_ci (subscriber)
    Send_message (subscriber,CI)
    Receive_message()
    Profit=Profit+CI
```

Alg. 5. Charge for shout quote.

```
Charge_co(shout)
    Send_message(shout,CO)
    Receive_message()
    Profit=Profit+CO
```

Alg. 6. Charge for Transaction and profit quotes.

```
Charge_ct_cb (bid, ask, P_T)
    v_bi= bid.price
    v_si= ask.price
    pr_bi=| v_bi - P_T|
    pr_si=| P_T  - v_si|
    bid_profit_fee = pr_bi*CB
    Cobrar_ct(bid, bid_profit_fee)
    Send_message(bid, bid_profit_fee)
    Receive_message()
    ask_profit_fee = pr_si*CB
    Charge_ct(ask, ask_profit_fee)
    Send_message(ask, ask_profit_fee)
    Receive_message()
    Profit=Profit+( bid_profit_fee + ask_profit_fee)
    N_T= N_T+1
```

Alg. 7. Charge for Transaction quote

```
Charge_ct (shout, profit_fee)
    Transaction_fee=| profit_fee *0.1|
    Send_message(shout, transaction_fee)
    Receive_message()
    Profit=Profit+ transaction_fee
```

In the next section experimental results using shout accepting and prices policies like is proposed in [11] and quote policies proposed in this paper are shown.

6 Experiments and Results

All the experiments were carried out and tested on JCAT platform using a local server [3].

6.1 Experimental Setup

Each experiment considered four specialists M1, M2, M3 (dummies) and Tianuani, the total number of traders are 100 (50 sellers and 50 buyers). The elapsed time was 100 days of game. Each day has 10 rounds and each round lasted 500 milliseconds. The graphics in section 6.2 represent the impact on the market of the proposed charging policy.

6.2 Results

Figure 2 shows profit obtained for each specialist, when they apply its quote policy.

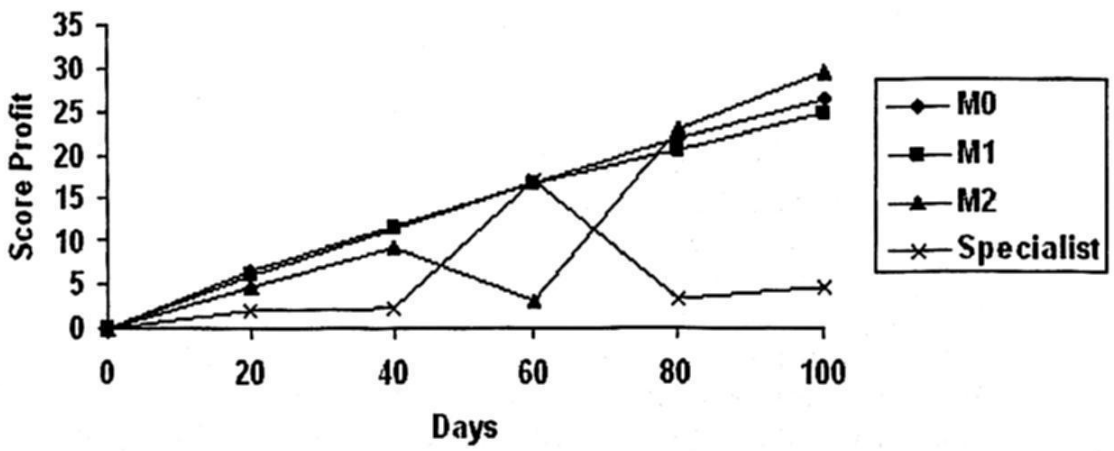

Fig. 2. Total Profit

Figure 2 shows that in the 20 first days of competition, the specialist remains more time in TCS state, therefore its profit keep constant and low. Between days 20 to 60 the specialist keeps itself more time in PMS state and its profit increases reaching the same profit of the other specialists (M0, M1 and M2). In the last days, Tianuani is more time in TMS state, it lost profit, since it had to maximize the number of matching by decrementing its quotes.

In Figure 3 transactions scores of each specialist is shown. It can be noted Tianuani from the 40 day beats the rest of the agents. This improved behavior is due to the decreasing of the quotes and then a greater number of shouts were captured.

In Figure 4, the trader's attraction for each specialist, in terms of the total percentage of registered traders in the game, is shown.

It can be noted Tianuani's behavior beats the remainder agents. From day 0 to 20 Tianuani keeps capturing traders in an increasing way and from day 40 until 100 it performs steady, outperforming in general the dummies'. Because of the quotes are decreased by Tianuani, a greater number of traders showed interest in to trade with it.

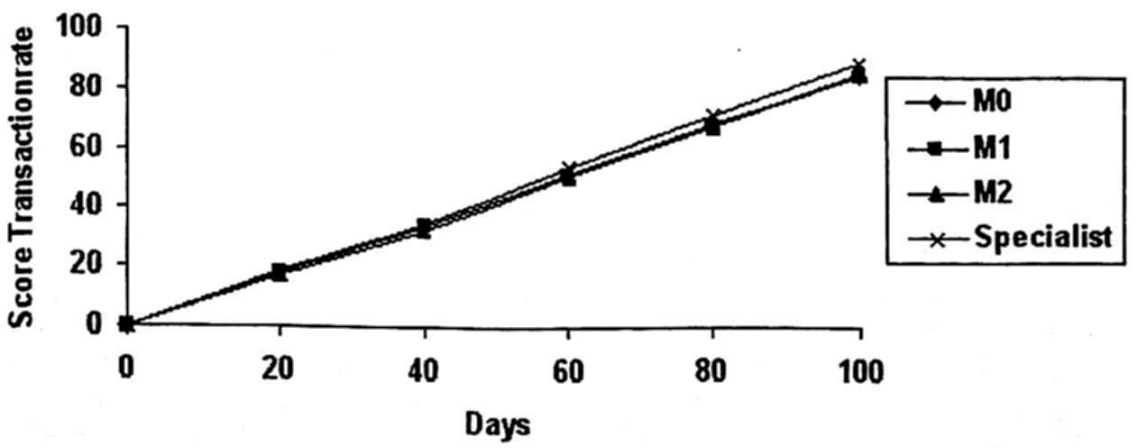

Fig. 3. Scores on transactions.

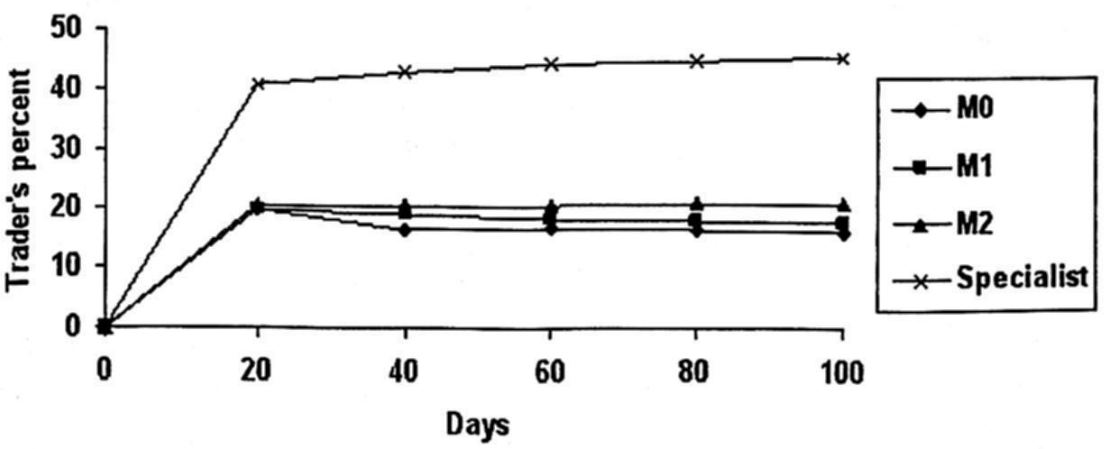

Fig. 4. Traders registered by specialist

7 Conclusions and Ongoing Work

Design and implementation of strategies were developed in order to establish charging policy. Tianuani obtains better number of transactions respect to the rest of the specialists (dummies). Considering performance based on how much traders Tianuani can attract, ours performed better than the reported results in [11], using both accepting and price policies at the same time.

Tianuani goes through diverse development steps. Initially, improvements for accepting and pricing policies were implemented. Results at this moment report a better trader's capture respect to the other specialists but the number of transactions was under the rest. Second improvement step consisted on to improve charging policy which positively impacted in a greater number of transactions and registered traders respect previous reports. Actually, an efficient clearing policy is under test given more capabilities to interact when all policies can be applied to a specific market situation.

Even though Tianuani enhanced its overall performance by improving its policies' strategies, it is still been updated. TAC CAT World Competition is coming soon and Tianuani will be playing and also train it with specialist agents from different countries.

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