The Role of Social Image as a Behavior Filter: A Case Study Based on Cognitive Agents *

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Abstract. *In multi-agent systems (MAS), computational reputation models have been adopted as an important solution in order to ensure security and efficiency. The evaluation mechanisms, offered by these models, can be used to punish inappropriate behaviors of agents and improve the partner selection process in uncertain situations. However, as the reputation is a shared opinion, in some cases, a given agent can be penalized excessively and no longer be chosen as a negotiation partner, even when he is not a cheater. In this context, in this work, we investigate how the social image, a social evaluation about the characteristics of someone, can be used to avoid very severe punishments, as well, its effects on the decisions taken by an agent about its negotiation partners, assuming that these decisions are initially made based only on reputation of other agents. Our results demonstrate that, in some scenarios, social image may lead an agent to be more flexible during the selection of his negotiation partners.*

Resumo. *Nos sistemas multi-agente (SMA), os modelos de reputação computacionais têm sido adotados como solução importante para garantir segurança e eficiência. Os mecanismos de avaliação, oferecidos por esses modelos, podem ser usados para punir comportamentos inapropriados dos agentes e melhorar o processo de seleção de parceiros em situações de incertezas. No entanto, como a reputação é uma opinião compartilhada, em alguns casos, um determinado agente pode ser penalizado excessivamente e não ser mais escolhido como parceiro de negociação, mesmo esse não sendo um trapaceiro. Nesse contexto, neste trabalho, investigamos como a imagem social, uma avaliação social sobre as características de alguém, pode ser usada para evitar punições demasiadamente severas, assim como os efeitos da imagem social nas decisões tomadas por um dado agente sobre seus parceiros de negociação, assumindo que tais decisões são inicialmente feitas considerando somente a reputação dos demais agentes. Nossos resultados demonstram que, em alguns cenários, a imagem social pode levar o agente a ser mais flexível durante a seleção de seus parceiros de negociação.*

1. Introduction

Reputation is a fundamental aspect for human relations, generally it is associated to how much reliable someone is. According to [Sabater and Sierra 2001], reputation can be defined as an opinion of a person about something. In particular, this opinion is formed and updated along the time, either from direct interactions or through information provided by other members of the society. There are several reputation models that translate some reputation concepts from human world to virtual societies [Sabater and Sierra 2001], [Huynh et al. 2004], [Sabater et al. 2006], [Pinyol et al. 2012] and [Borges et al. 2015].

Reputation models are fundamental to design and implement agent systems [Luck et al. 2005]. According to [Pinyol and Sabater-Mir 2013] a reputation model aggregates important information that agents can use to select their partners. In general, the choices performed by an agent are based on the social behavior of other agents in the society. Hence, the most severe punishment for bad behavior is the social rejection. On the one hand, as discussed in [Sabater and Sierra 2005], this approach contributes to search trustful partners and to avoid cheaters and frauds in virtual societies. On the other hand, according to severity of punishment applied for bad behavior, an agent can be socially excluded without necessarily to be a cheater. For instance, consider a situation, where a given agent has received a series of bad evaluations for failing to perform a task as promised. Thus, a bad reputation about the agent's behavior will spread in the society, and due to this, such agent will be refused as partner in future negotiations. However, if the agent's failures occurred due to the unavailability of resources, in the future, according to the severity of evaluations, the agent may continue being refused, even when he gets the necessary resources to perform the task very well.

In particular, the unfair punishment problem can be minimized by using of social image, since the selection of partners is based on the roles or functions performed by agents in the society. As presented in [Sabater et al. 2006], social image can be defined as a social evaluation consisting of a set of evaluations about the characteristics of a target (someone or something). In this approach, a rating (*e.g.*, good or bad), is associated to a target according to the functions performed by it. The difference between reputation and social image can be exemplified through a commercial scenario, where several customers consider and share each other the information that a given seller is a cheater (reputation), because great part of his products are low quality products. However, for some products, besides good quality, the seller offers the lowest prices in the market. Thus, even if the customers know about the seller's reputation, for some products, the purchase is advantageous due to good image that the customers have about the seller. Notice that, in this case, the seller performs different functions when sells low or good quality products.

In [Sabater et al. 2006] and [Pinyol et al. 2012], the social image and reputation are used simultaneously to provide evaluations on potential negotiation partners in a multi-agent context. In particular, the authors discuss the effects of social image on reputation, and vice-versa, considering the social relations existing among agents. An important consideration adopted by authors is that, both image and reputation can be shared among agents. However, in the case of social image, the speaker agent must commit himself to the veracity of the information transmitted. Furthermore, according to [Conte and Paolucci 2002], social image is a belief usually produced from the direct experiences of the agent, and hence, expressing a more personal opinion about a target. On

the other hand, reputation is defined as meta-belief, since it is produced based on third party opinions that circulate in the society. In this way, reputation can be seen as a general opinion shared by the majority of the member of the society. In this way, reputation can be seen as a general opinion shared by the majority of the member of the society.

In this work, we investigate how the social image can be used to avoid very severe punishments resultant of reputation evaluations, as well, the effects of social image on the decisions taken by agents about their negotiation partners, considering the reputation information spread on the society. Differently of the approach adopted in [Sabater et al. 2006] and [Pinyol et al. 2012], in which image and reputation are applied in a cognitive model, where the agents can join to trust groups and decide when it is advantageous spread or omit the reputation or social image information about someone, we are using the social image as a filter for identify good behaviors, and therefore, good negotiation partners. In particular, in our approach, each agent has its own image about its candidate partners, which can be used to reward or punish such candidates based on the functions performed by them. In our experiments, we notice that when social image and reputation are used together, variations on the behavior of a given agent are more easily noted by other members of the society. Hence, agents penalized in initial negotiations due to bad behavior, may be selected more easily in future negotiations if they improve their behaviors.

The rest of this paper is organized as follow. Section II presents the modeling considerations adopted to compute the reputation and social image values. Section III discusses the details of implementation and the case study used in our experiments. Section IV describes the experimental results and discusses the result obtained. Finally, the conclusions and the future works are summarized in Section V.

2. Reputation and Social Image Modeling

This section reviews some definitions and the main concepts regarding the modeling of the reputation and social image adopted in this work. This modeling was based on Regret [Sabater and Sierra 2001] and FIRE [Huynh et al. 2004], since they also adopt a commercial transactions scenario in their experiments. In our case, as case study, we implement a commercial transactions system, where agents interact each other making use of behavior evaluations that are circulating on the society (reputation), as well as through their own evaluations about the characteristics of a given agent (social image). In particular, a commercial transaction can be seen as an agreement, which is performed between two agents and defines the terms of a contract. Similarly to the Regret and FIRE models, we consider that in a commercial transaction an agent X buys a certain product from an agent Y and after that the agent X rates the agent Y according to the conditions of a contract of service (*e.g.*, product price, product quality, and delivery time).

2.1. Ratings

As defined in [Sabater and Sierra 2001], a commercial transaction is an agreement between two agents that specify the terms and conditions of a commercial contract (*e. g.*, the expected quality and the delivery date of a certain product purchased by someone). Thus, when an agent X buys a product from an agent Y through a commercial transaction, an outcome is created, which represents the contract conditions agreed by both agents, X

and *Y*. In our case study, an outcome is defined in terms of price, quality, and delivery time of a product. For instance, the following outcome O_{xy} could be the result of a commercial transaction between agent *X* and agent *Y*:

$$0_{xy} : product_{price} == 100 \wedge product_{quality} == 80\% \wedge product_{delivery\ time} == 10$$

this means that agent *X* expects paying 100 dollars by a given product with quality of 80%. Moreover, such product must be delivered within 10 days by agent *Y*. Notice that when this outcome is produced, an expectation is created by agent *X* in relation to agent *Y*. Thus, as discussed in [Castelfranchi and Guerini 2007], agent *X* believes that agent *Y* will commit to the terms of contract. Therefore, when the product is delivered by agent *Y*, agent *X*, based on its expectations, can evaluate agent *Y*. In particular, to make such evaluation, agent *X* must consider its satisfaction with respect to the service provided by agent *X* [Castelfranchi and Falcone 2010]. Thus, as a result of the evaluation, the appraiser agent, in this case agent *X*, is going to produce a rating $r : (x, y, i, c, v)$, where *x* represents the appraiser agent, *y* the appraised agent, *i* the time instant in which the rating was produced, *c* the contract term considered in evaluation (price, quality, or delivery time) and *v* the value associated to the contract term, which belongs to the interval [0, 1], where 0 means a rating absolutely negative, 1.0 means a rating absolutely positive, and 0.5 means neutral rating.

In conclusion, all ratings produced by a given appraiser agent are stored in its belief base. Thus, the appraiser can memorize its impressions about other agents. In general way, an impression is compound of the ratings given for each contract term agreed in a certain commercial transaction. Therefore, the impression $imp_y^x : (r_{c=price}, r_{c=quality}, r_{c=delivery})$ stores a set of ratings (*r*) made by the agent *x*, in a certain instant *i*, about an agent *y*, in which a value *v* is associated to a each one of contract terms *c* (price, quality, and delivery time). Furthermore, impressions memorized by an appraiser can be shared with other agents in order to spread the reputation of a given target. Therefore, the reputation of a certain agent is built according to impressions about it that are produced and shared among members of the society.

2.2. Reputation

As performed in [Sabater and Sierra 2001] and [Huynh et al. 2004], for computing the reputation, we will use the weighted mean of the impressions. This approach groups a set of impressions together in order to form a single summary value, giving more relevance to impressions received most recently. The equation used to compute the reputation is:

$$R^t(IBD_f^x) = \sum_{\iota_i \in IBD_f^x} p(t, t_i).W_i \tag{1}$$

where R^t, represents a reputation value in a given time instant *t*, IBD_f^x indicates all impressions from belief base of agent *x* filtered by one or more terms of contract (*c*), which are selected according to a given filter *f*. For instance, this filter could select all the impressions of an agent *x* about the agent *y*, considering as contract terms, the product price and delivery time. Furthermore, $p(t, t_i)$ represents a time dependent function that prioritizes impressions produced closer to time instant *t*, (*e.g.*, $\frac{t_i}{t}$), and W_i indicates a value (*v*), within interval [0, 1], assigned to selected contract term (*c*). A complete discussion and specific details about this equation can be found in [Sabater and Sierra 2001].

Besides reputation value (R^t), we calculate the reliability of reputation, as specified in [Sabater and Sierra 2001]. In particular, from reliability of reputation, it is possible to establish how much truthful the reputation of someone or something is, since the impressions used for computing reputation may come from unreliable sources. Basically, the reliability value is computed taking into account two factors: (*i*) the number of impressions adopted to calculate the reputation, isolated experience is not enough to make a correct judgement of someone; and (*ii*) subjective reputation deviation, which aims measure the variability of impressions used in reputation computing. According to [Sabater and Sierra 2001], high variability indicates a low credibility reputation.

2.3. Social image

As discussed previously, image is a social evaluation associated to functions or roles that a given target plays. Furthermore, different members of a society may have different images about the same target. For instance, in a commerce scenario, agent x may have the social image that the prices of books sold by agent y are fair (agent x has a good social image of agent y as book seller). On the other hand, at the same time, agent x may believe that the magazines sold by agent y are very expensive (agent x has a bad social image of agent y as magazine seller). Therefore, for agent x, agent y can be seen from different perspectives, according to the type of product that agent x wants buying. However, notice that, independently of agent x's image about agent y, in the society, agent y may have a bad reputation as a seller in general way. Besides, it is important to notice that social image is produced through own impressions of an agent with respect to the observed characteristics of a target. Due to this detail, social image as social evaluation, tends to be more sensitive to direct interactions performed among agents than reputation.

In our experiments, the social image concept is employed as a product filter used to select good sellers based on experiences of buyers. In particular, when a buyer purchases a product of a seller, the impression resulting from this transaction is stored in the belief base of the buyer as part of the social image of the seller. However, besides contract terms, this impression has a reference to the product sold by seller. Such detail allows the buyer to filter the sellers by product, instead of just using contract terms. Thus, whether a buyer buys a specific product of a seller, and has a good impression about it, in the future, case this buyer needs buying a similar product, he may select the same seller of last time, independently of reputation of such seller. Therefore, in this approach, sellers who sell well only some products, are only penalized for the bad sales of other products.

The social image is computed from an aggregation of impressions, similar to reputation. Thus, in our experiments, we also use the Equation 1 to compute the social image value. However, differently of reputation, the social image value is calculated using only the own impressions of agent, which are obtained from direct interactions (*e.g.*, the filter f in the Equation 1, could be configured to select just the impressions produced by own agent, this effect is obtained setting the appraiser agent (x) as *"self"* before to perform a search for impressions on the belief base of the appraiser agent.). Additionally, in this case, the impressions are filtered based on the product desired by the appraiser agent, since every purchased products and their respective sellers are stored in the belief base of buyer agents. Thus, besides contract terms (product price, product quality, and delivery time), in the social image computing, the type of product is also considered.

3. Commercial Transaction System

In this section, we present the implementation details about the commercial transaction system implemented as our case study. In general way, the system consist of two distinct groups of agents, Buyers, represented by set $\mathbf{B} : \{b_1, b_2, ...b_n\}$ and Sellers, represented by set $\mathbf{S} : \{s_1, s_2, ...s_m\}$. These agent groups interact with each other through buying requests, which are produced from buyers and consumed by sellers. Each buying request results in a commercial transaction, which in turn, generates an impression that is used to compute the social image and reputation values, as appears in Figure 1. Notice that a tuple $R^t(s_i, price, quality, delivery)$ is associated to reputation of the seller s_i, which is computed in the instant t, considering each evaluation criterion (product price, product quality, and delivery time). In turn, a tuple $Image(s_i, product, imp_{s_i}^{b_i})$, associates the seller s_i to a given impression, which is produced in a certain time instant, from a purchase of a specific product. Notice also that the sellers reputations are shared by all buyers, differently of social image, which is particular for each buyer. Moreover, all agents were implemented in Jason [Bordini and Hübner 2005], an interpreter for an extended version of AgentSpeak [Rao 1996].

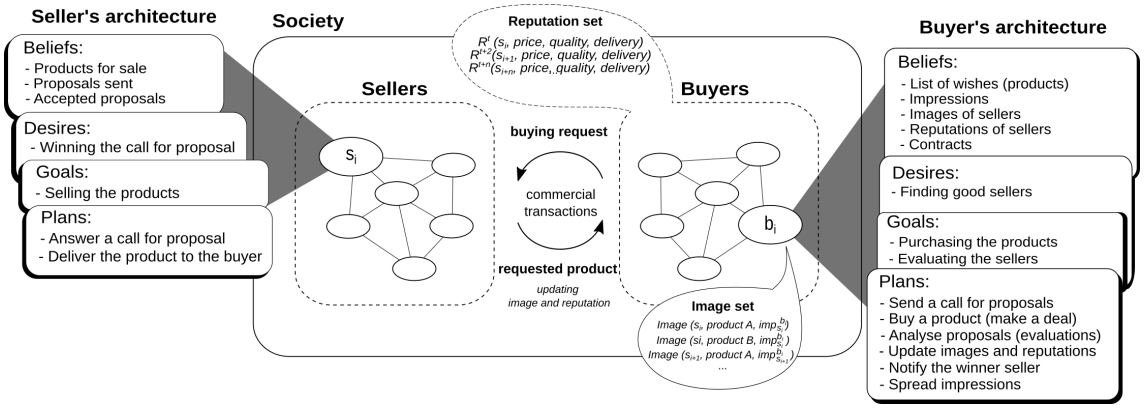

Figure 1. Commercial transaction system, buying request cycle and architectures of the agents

3.1. Buyer Agents

Buyers start the commercial transactions asking for a product. Each buyer $b \in \mathbf{B}$ has its own list of wishes, which consists of products that may or not be acquired as a result of a commercial transaction. In some cases, when there are not sellers who sell the product specified by the buyer, the current transaction is ended and defined as aborted. After that, a new transaction is started and this process is repeated until the list of wishes of the buyer is empty. In particular, the buyers are divided into two types, (*i*) one-condition oriented, which is focused on just one contract conditions, as product price, product quality, or delivery time. Thus, buyers oriented to price just care about low cost products, ignoring the others contract terms. (*ii*) multi-conditions oriented, in this case, it is possible to customize the relevance of each contract term. For instance, the following relevance tuple $p_{b_i} : (price = 1, quality = 0, delivery\ time = 0.5)$, indicates that for buyer b_i the product price term must be defined as the highest priority, the product quality is not important, and the delivery time is partially relevant.

3.2. Seller Agents

Each seller $s \in \mathbf{S}$ has its own list of products for sale, which may or not be exclusive. The main goal of a seller is to try to satisfy the buying requests that come from buyers. However, it is possible that more than one seller can meet a given buying request. In this case, a race condition occurs, which can be solved considering the buying orientations of the buyer (price oriented, quality oriented, or delivery time oriented), or ranking the sellers based on their reputation and social image. In general, sellers may lie, in this case, the seller changes the contract conditions agreed with buyer and deliver the product out of initial specifications. The severity of the lie depends on the profile of the seller and on the product's type, because there are products that are easier to sell than others. In this way, the more difficult it is to sell the product, the greater is the chance of seller lying. With respect to sellers profiles, there are three types of sellers, (*i*) good seller, which never lies. Independently of product's type, a good seller always fulfils the contract conditions; (*ii*) bad seller, which always lies, indifferently of product's type; and (*iii*) general seller: this seller has its behavior defined according to type of product added in its list of products.

3.3. Social Interactions

In order to ensure the correct functioning of commercial transactions, the contract net protocol (CNP) was implemented. The CNP was proposed by [Smith 1980] and is used to allocate tasks among autonomous agents. In particular, the protocol starts when a buyer $b \in \mathbf{B}$ receives a perception from the environment about the product that must be purchased. In this moment, a call-for-proposal (*cfp*) is sent to all sellers in the society. In this call, the buyer b_i specifies the product that want to buy and the identifier of call (id), since several *cfp* may be triggered at the same time by different buyers. When a seller $s \in \mathbf{S}$ receives a *cfp*, and has the requested product, such seller sends a proposal to the respective buyer; otherwise, he does not answer the *cfp*. The sent proposal contains the contract conditions defined by the seller, which may be changed in the future without consent of the buyer. In turn, upon receiving all proposals, the buyer b analyzes each one and selects the best one based on its profile, the seller's reputation and the seller's social image with respect to requested product. Finally, after the seller delivers the product, based on its expectations, the buyer evaluates the seller and produces its impression, which is shared with the others buyers.

4. Experiments and Results

In this section we present our experimental study. In particular, all experiments presented herein are based on buying and selling scenarios, where buyers interact with sellers in order to purchase some specific products. In our analysis, we are considering two distinct situations. In the first one, the purchases performed by buyers are guided the buying requirements (*e.g.*, low price, good quality, and short delivery time) and based on reputations of sellers. In turn, in the second situation, besides buying requirements and reputation information, we are also considering the social image influence on the decisions taken by buyers about their partners.

4.1. Sale Patterns

As discussed previously, the social behavior of the sellers is influenced by the type of products sold by them. Thus, in order to simulate different sale patterns, behavioral functions are associated to the products sold by sellers. Above all, a behavioral function

defines how much a seller must change the original contract conditions of a given product before deliver it to the buyer. Therefore, according to the behavioral function adopted, the commitment of sellers with the original contract conditions may be changed along the time. Moreover, notice that the behavioral functions affect directly the reputation of sellers, since a seller may become a cheater due to lack of commitment with its promises. The behavioral functions used in our experiments are described below:

- *Constant*: products associated to this kind of function are easy to sell. Thus, the seller does not need to lie. Therefore, sellers fulfilment the contract conditions, delivering the product to buyers as promised.
- *Increase-function*: this function represents the situation where a seller starts his business very well (not lying), but along the time, the seller needs lying in order to keep himself on the market. In this case, sellers tend increasing the value of one or more contract conditions before deliver the product to buyer, since the resulting value of equation is multiplied by the contract conditions. The equation adopted to simulate this behaviour is the following:

$$f_{INC}(i) = \frac{\log_2 i}{n} \tag{2}$$

  where n represents the number of buying requests performed by buyers. In particular, every buyers perform the same number of buying requests. Moreover, each buying request has an identifier (i) and may be won by only one seller. Therefore, the identifier i belongs to the interval [1, n], where 1 means the first buying request performed by a buyer and n means the last one.

- *Decrease-function*: this function represents a situation where the seller starts lying and then he tries improving his behaviour in the next transactions. The equation adopted is the following:

$$f_{DEC}(i) = C - \frac{\log_2 i}{n} \tag{3}$$

  where, similar to the Equation 2, i represents the current transaction and n represents the total of transactions that will be performed. In turn, the constant C indicates the initial value of lie told by the seller in the beginning of experiment. Notice that this value tends to decrease over time. In particular, in our experiments, the values obtained from the functions described by Equation 2 and Equation 3 are translated to the interval [0, 1], where 0 represents no changes on the contract conditions, and 1 represents the maximum change value (doubles the original value of one or more contract conditions).

4.2. Single Seller

In this experiment, a buyer has a list of wishes compounds of 10 products. These products are divided into products of type *A* and type *B*, which are purchased in a specific sequence, as shown in Figure 2. In particular, the buyer has a price oriented profile, and hence searches for low price products. Moreover, the buyer negotiates with a single seller. On the other hand, the seller is a general seller that sells products of type *A*, which is associated to a constant behavioral function, and also, products of type *B*, which is associated to a high-growth behavioral function.

In Figure 2 (a), all purchases performed by buyer are just based on seller's reputation. Thus, the commercial transactions are established only when the seller's reputation is above of the acceptable reputation limit (0.8). Thus, when the seller's reputation is below of reputation limit, the commercial transaction is canceled and the sale is not performed (aborted sale). In Figure 2 (a), when a product of type B is sold in iteration 4, the seller's reputation, in regard to product price, becomes lower than reputation limit, and this way, no sales are made from this point forward. In turn, when the social image filter is applied, the decisions of buyer become more flexible, as presented in Figure 2 (b). Notice that in iteration 5, the buyer purchases the product *B*, despite the seller's low reputation. In this case, as the social image of the buyer about the seller, regarding product *B*, is acceptable (above 0.6), the purchase is performed, as it is shown in Figure 2 (b) and Table 1 (c). In particular, as the impressions used for social image computing come from the own agent, presenting high reliability, we are assuming that the acceptable social image limit is lower than the reputation limit. Another important observation about the use of social image filter, can be notice in iterations 8 and 10, where the sales of the products of type *A* are made due to high image values.

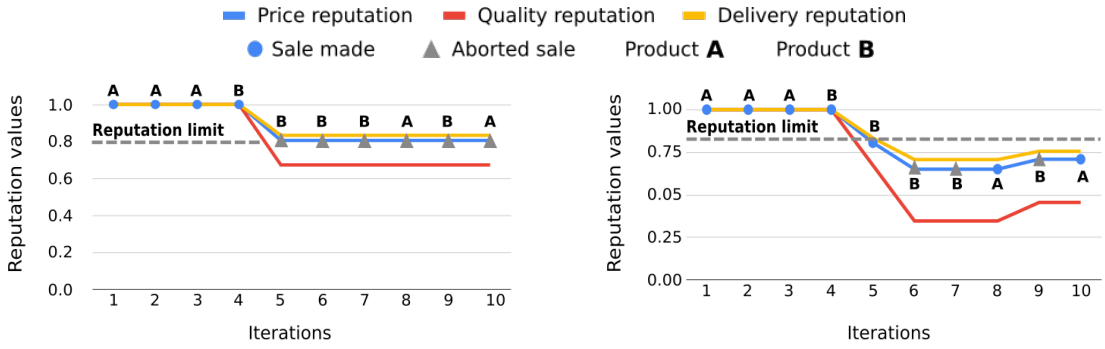

Figure 2. Influence of social image filter on the seller's reputation: (a) sales made by seller taking into account just the reputation values, and (b) sales performed by a seller considering the social image filter.

Iteration	Product	Price image	Quality image	Delivery image
1	A	-	-	-
2	A	1.00	1.00	1.00
3	A	1.00	1.00	1.00
4	B	-	-	-
5	B	0.61	0.35	0.67
6	B	0.56	0.18	0.63
7	B	0.52	0.12	0.58
8	A	1.00	1.00	1.00
9	B	0.47	0.09	0.53
10	A	1.00	1.00	1.00

Table 1. Seller's social image considering the single seller experiment.

4.3. Seller Competitions

In this experiment, a buyer needs to purchase 20 products, which are divided into products of type *A* and type *B*, which must be purchased in a specific sequence, similar the previous

experiment. Moreover, the buyer is a general buyer, searching for products with a good trade-off between price and quality. In turn, there are two sellers, *seller 1* and *seller 2*, as presented in Figure 3. Both sellers are general sellers, and this way, the social behavior these sellers are defined according to products sold by them. In particular, both sellers sell the same products, of type *A* and type *B*. In the case of *seller 1*, a behavioral function of type semi-constant is associated to the products of type *A* as well to the products of type *B*, whereas for *seller 2*, a behavioral function of type constant is associated to the products of type *A* and a high-growth function is associated to the products of type *B*. Furthermore, the products sold by *seller 2* are 20% cheaper and with quality 20% better than products sold by *seller 1*.

Notice that when the experiment starts, in Figure 3 (a), the buyer selects the *seller 2* as negotiation partner, since its products are better and cheaper than products sold by *seller 1*. However, when the reputation of *seller 2* becomes lower than reputation limit, between the iterations 7 and 8, the buyer selects the *seller 1* as its new negotiation partner, which is kept until the end of experiment. On the other hand, in Figure 3 (b), when the social image filter is applied, the *seller 2* gets to sell more products of type *B* before the buyer selects the *seller 1* as partner. Moreover, in iterations 18, 19 and 20, the buyer selects the *seller 2* again as negotiation partner due to the high image value of products of type *A*, Table 2 (c). Notice that the sales of products of type *A* increase the reputation of *seller 2*, since good impressions are produced from these sales.

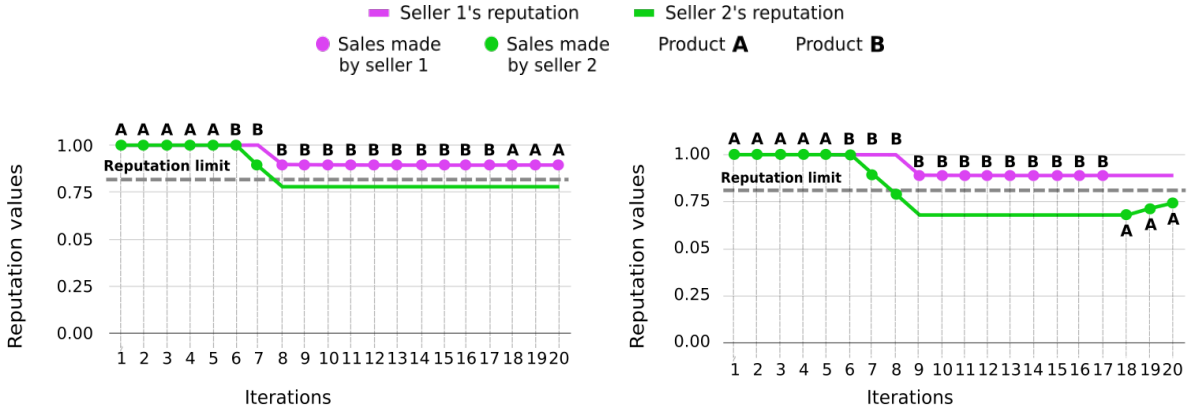

Figure 3. Agents competing for sales: (a) using just reputation values to select the best seller, and (b) influence of social image on partner selection.

Iteration	Product	Seller1's image	Seller2's image
6	B	-	1.00
7	B	-	0.65
8	B	-	0.61
9	B	-	0.57
10	B	0.95	0.57
18	A	-	1.00
19	A	-	1.00
20	A	-	1.00

Table 2. Sellers' social image considering the seller competitions experiment.

4.4. Results Analysis

In our experiments, we remark the use of social image, as behavior filter, makes the agents decisions making, with respect to the selection of their negotiation partners, more flexible than when the agents just consider the information about reputation. Thus, punishments for bad behavior tend to be fairer, since, besides agent's reputation (shared opinions by agents), the functions performed by agent in the society are also considered when such agent is punished.

On the other hand, we also notice that the social image may have a great influence on the reputation of agents, since the impressions produced from decision taken based on social image are shared in the society. This influence may be either positive or negative, depending on the expectations of appraiser agent with respect to service provided by the provider agent. In particular, as presented in Figure 2 (b) and Figure 3 (b), when the buyer selects a seller based on the social image, this decision affects the seller's reputation, because the impressions produced are used to update the reputation status of seller. Thus, whether a sequence of good impressions are produced from decisions based on social image, the seller's reputation can be improved, even if such seller is considered a cheater by other agents (from from a point of view). In turn, in our experiments, as the sellers are filtered by products, the image becomes more sensitive than reputation, since the social image needs of a smaller number of impressions to be computed.

5. Conclusions

In this paper we presented a particular study case, where agents interact each other from commercial transactions. In particular, buyer agents perform buying requests of certain products, and seller agents try to provide the requested product. Sellers are evaluated after the product delivery, where they are rated by the respective buyers. A rating express how much reliable the seller was with respect to fulfilment some contract (product price, product quality and delivery time). For a buyer, a rating is an impression, which is used to update the social image and the reputation of some seller.

Our experiments have demonstrated that variations on the behavior of agents are more easily noted when the social image and reputation are used together. In particular, we notice that social image has a great influence on an agent's reputation, since impressions produced from good experiences associated to social image are used to compute reputation. Therefore, whether a satisfactory number of good impressions is produced based on image of a given agent, the chances of this agent to be chosen as a negotiation partner in the future improve, independently of its reputation. Notice that in this situation, the evaluations based on social image consider the functions performed by agent in the society, besides its reputation.

As future work, we intend to explore the concept of trust in the agent relationships. In particular, when an agent uses the social image to select a given negotiation partner, a trust relationship is defined between the agents, in which an agent delegates a task to its partner and creates expectations about the fulfillment this task. Therefore, it is important that there is a minimum degree of commitment to the part of negotiation partner in order to meet the expectation of appraiser agent.

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