Openness, Conscientiousness and Stingy for Buyer and Seller Agents in Electronic Marketplace

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Abstract—In this paper we propose a model based on personality for buyer and seller agents in agent-based electronic marketplaces. The personality of buyer agents affects their behavior in market. Buyer agents use their own personality to evaluate the value of seller agents' bids. Also buyer agents apply reinforcement learning to evaluate the reputation of seller agents and then focus their trading on reputable sellers. On the other hand, the personality of seller agents affects them to consider discount for buyer agents. In addition, seller agents apply reinforcement learning to model the reputation of buyer agents. We have implemented this model with aglet which is a java based environment for building agents. Our results show that sellers with low score of stingy earn more benefits in comparison with high stingy sellers. Also, conscientious seller agents gain more reputation relative to conscienceless seller agents. On the other hand, buyer agents with high score of openness and low score of stingy purchase more new goods and more expensive goods relative to buyers with low score of openness and high score of stingy.

Index Terms—Reputation, Reinforcement Learning, Electronic Commerce Agents, personality.

I. INTRODUCTION

Buyer and seller behavior research involves various areas: psychology, marketing, sociology, economics and engineering [1]. Personality is one of the most important factors which profoundly affect the behavior of both buyers and sellers. The researches show that differences in personality types cause differences in trading behaviors of people. There are three types of data regarding consumer purchase decisions: 1) demographic data, 2) behavioral data, and 3) psychographic data. Psychographic data is characterized by attitudes, opinions, lifestyle characteristics, or personal values (personality, age, income and so on) [1], [2].

In addition, with the advent of mobile and intelligent agent technology, e-commerce has been entered in a new era of its life [3]. Agent-Based e-Marketplace is one of the most important results of using agent technology over Electronic Commerce. Electronic marketplace provides a single location for many buyers and sellers to congregate electronically and complete their own transactions. In the recent years, the extensive researches are focused on designing agent-based e-Marketplaces [4]-[6]. The main goal of agents' research is building human-like agents. In this situation, applying personality traits to electronic commerce agents make them more realism and human-like.

In this paper, we propose a model based on personality for buyer and seller agents in agent-based electronic marketplaces. We consider two personality traits for seller agents: stingy and conscientiousness. Stingy is a negative facet of Agreeableness trait [7]. Stingy seller agents are the sellers who like money so much, and try to maximize their benefits. Therefore, these seller agents consider a little discount for buyers. In other word, high score of stingy implies considering low discount and vise versa. Also, seller agents with personality trait conscientiousness are responsible, dutifulness and orderly. These sellers try to be trustful in the market. Their bids are compatible with the characteristics of their real goods. They do not lie about their goods and not try to cheat the buyers. High score of conscientiousness means, high dutifulness and conscientious and vise versa.

In addition, we use two personality traits for buyer agents: stingy and openness. Price of the goods is very important for stingy buyers. They focus on low price goods. Low score of stingy means that buyer agent is more spendthrift and prodigal. The price of goods is not so much important for the buyers with high score of spendthrift (low score of stingy). The other trait which is considered for buyer agents is openness. Researches show that openness trait is positively related to hedonic product value [8]. Buyer agents with these characteristics tend to purchase new and hedonic products. This tendency depends on their openness score. The paper is organized as follows: section 2 describes the related works. Proposed model is illustrated in section 3. We have tested this model in aglet [9], [10] which is a java based environment for building agents. The experimental results related to this simulation are presented in section 4. Finally, we conclude the paper and propose the future work in section 5.

II. REALATED WORK

Buyer and seller behavior research involves various areas: psychology, marketing, sociology, economics and engineering [1]. In subsection 2.A, we introduce some researches on personality in psychology. The relation between consumer behavior and personality is described in subsection 2.B and we explain some major and related works on agent-based electronic marketplaces in subsection 2.C.

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A. Personality in Psychology

There are two main models for personality: OCEAN [11] and Cattle [12]. OCEAN or Big Five model includes five factors: Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism. This model is shown in table I. Openness means a person is imaginative, independent-minded and divergent thinking. Conscientiousness describes the person who controls the impulse, following rules and norms. Also, they are responsible, dependable and orderly. Extraversion means that a person is talkative, social and assertive. Agreeableness means a person is good natured, co-operative, and trusting. Neuroticism means a person is anxious, prone to depression and worries a lot [13].

TABLE I: Ocean Model of Personality

	High Score Traits	Low Score Traits
Openness	Creative, Curious, Complex	Conventional, Narrow, Interests, Uncreative
Conscientiousness	Reliable, Well-Organized, Self-disciplined, Careful	Disorganized, Undependable, Negligent
Extraversion	Sociable, Friendly, Fun-loving, Talkative	Introverted, Reserved, Inhibited, Quiet
Agreeableness	Good natured, Sympathetic, Forgiving, Courteous	Critical, Rude, Harsh, Callous
Neuroticism	Nervous, High-strung, Insecure, Worrying	Calm, Relaxed, Secure, Hardy

The other model is cattle. This model categorize the personality into 16 traits: Warmth, Reasoning, Emotional Stability, Dominance, Liveliness, Rule-Consciousness, Social Boldness, Sensitivity, Vigilance, Abstractedness, Privateness, Apprehension, Openness to Change, Self-Reliance, Perfectionism and Tension [12].

B. Personality and Consumer Behavior

There are some researches which prove that personality is strongly connected to consumer purchase decision making process. [14] focuses on two personality traits for evaluating buyers online shopping: openness to change and vigilance. Results showed that Vigilance, or suspiciousness, was negatively associated with Internet purchasing behaviors that required commitment such as giving credit card or personal information. Vigilance was also negatively associated with Internet usage attitudes demonstrating a relationship between trust and Internet comfort levels. These results support the hypothesis that Vigilance as a personality factor can influence Internet shopping behaviors. Also, Results showed that the Openness to Change personality trait was positively associated with Internet behaviors and attitudes. This supports the hypothesis that Openness to Change as a personality factor can influence Internet shopping behaviors.

Mowen in [15] proposes 3M model for consumer online shopping behavior based on OCEAN model.

In addition, researches show that openness trait is positively related to hedonic product value and directly influence brand affect which in turn drives attitudinal and purchase loyalty [8].

C. Agent-Based Marketplaces

There a lot of works on agent-based marketplaces. In this subsection, we refer to some of them which are related to our work. [16] address the problem of how buying and selling agents should behave in an information economy such as the University of Michigan Digital Library. They divide agents into classes corresponding to the agents' capabilities of modeling other agents. [17]-[19] exploit reinforcement learning for buying agents to model the reputation of selling agents to protect buyers from communicating with non-reputable sellers. Nevertheless, buyers in this model should have fixed priorities on quality and price of their desired goods. In this way, they can not change their preferences to buy a good in a sequence of purchases. That is, a buying agent can not purchase a good in an auction with priority on quality and willing to buy the same good in another auction with priority on price. In addition, selling agents do not model the reputation of buyers to consider discount and just only focuses on two factors of quality and price. Roozmand in [3] proposes a market model, in which, selling agents model the reputation of buying agents and consider discount for them based on their reputation. Also, [1] propose a model for consumer puchasing decision process based on lifestlye and personality traits. The core of this model is a motivation function that combines consumers' psychological personality traits with two important kinds of interactions in a competitive market. The model reveals the inner psychological mechanism on the basis of which consumers make their choices when facing competing brands on the market.

III. Proposed Model

We propose a market model based on personality and reinforcement learning for buyer and seller agents. The transactions in market between buyer and seller agents are based on contract net protocol [20], [21]. Where buyers announce their requests for goods to all sellers via multicast or possibly broadcast and then sellers who have that good to sell, send the bids to the buyer. Afterwards, buyer evaluates the bids and selects the seller which more satisfies his own preferences.

The key point of this work is considering the personality for buyer and seller agents. It is very important to mention that it is so complex to consider all personality traits for buyer and seller agents. Therefore, only we have considered two personality traits for buyer and seller agents which are more related to transactions in the market. Openness and

stingy for buyers, stingy and conscientiousness for sellers. We introduce the seller and buyer algorithms in subsections 3.1 and 3.2 respectively.

A. Seller Algorithms

Assume that function $c^s(g,q,b)$ be the function for calculating the cost of good g, with quality q for buyer b. $stingy_s$ and $cons_s$ are the score of stingy and conscientiousness of seller s, respectively. These two values specify the personality of seller s. we show the personality of seller s based on these two personality traits as follows:

$$P^s = [stingy_s, cons_s] \quad stingy_s, cons_s \in [0,1] \quad (1)$$

Assume that seller s produces good g with the cost of $c^s(g,q,b)$, the maximum price for seller s is evaluated as follows:

$$p_{\max} = c^s(g,q,b) + c^s(g,q,b)*(\kappa + (1-cons_s)) \quad (2)$$

In which, κ is the reasonable percent of profit based on market norms for seller s. $cons_s$ is the score of conscientious of seller s. It is clear that high score of conscientious of seller causes lower price and vise versa. After receiving the buyer request for good g, seller s adjusts the bid for the buyer. This bid includes two factors: quality and price. There are some sellers who try to cheat the buyers by offering high quality goods and delivering them low quality goods. In other word, these sellers do not say the real quality of their goods. For example, they have good g with quality q=50 to sell. However, they offer their good with quality more than 50, for example q=60, and then deliver the good with quality 50 to the buyer. In this situation, buyer b evaluates the good with quality 60 and may select it to purchase. Lying about the characteristics of the goods really depends on the score of conscientiousness of the seller. Seller s adjusts the bid by equation (3).

$$q_{bid} = q_{real} + q_{real}*(1-cons_s) \quad (3)$$

In which, q_{bid} is the quality which is offered to buyer. q_{real} is the real quality of the good. $cons_s$ is the score of conscientiousness of the seller.

Assume that seller s to sell good g with quality q_{bid} at price p to buyer . It means that seller s has presented a bid better than the other sellers' bids to buyer b. Therefore, seller s may be re-selected by buyer b if seller s repeats this bid again for buyer b for specified good g. Seller s delivers product to buyer b and updates the reputation of buyer b using reinforcement learning [3]. The default value of reputation is zero: $r^s(b) = 0$:

$$r^s(b) = r^s(b) + \mu(1-r^s(b)) \quad (4)$$

Where, μ is a positive factor called cooperative factor and is equal to:

$$\mu = \frac{p - c^s(g,q,b)}{p_{\max} - c^s(g,q,b)} \quad (5)$$

In which, $p_{\max} - c^s(g,q,b)$ is the maximum profit for seller s if it could sell good g to b.

So the new bid for buyer b based on its new reputation is calculated by seller s as follows:

$$p_{new} = p_s - (r^s_{new}(b) - r^s_{before}(b))*(1-stingy_s)*p_s \quad (6)$$

In which $(r^s_{new}(b) - r^s_{before}(b))*(stingy_s)*p_s$ is the discount which seller s consider to buyer b. If seller s has maximum score of stingy (stingy=1), so he does not consider any discount for buyer b.

Now assume that seller s not succeed to sell good g with quality q_{bid} at price p to buyer . in this situation, seller s has to reduce the price of the good to sell the good in another transactions to buyer b. it is clear that if seller s continue the previous bid, he can not sell the good. He alters his bid based the equation 7:

$$p_{new} = p_s - (rp*p_s) \quad (7)$$

Let rp be a variable that specifies the reduction percent of price for seller who want to delivers his product late. That is, he should reduce the price of his product according to this value.

if $p_{new} < c^s(g,q,b)$, then seller s does not suggest the same good with previous quality. So that, he may optionally raise the value of quality by increasing its production cost as follows:

$$c^s(g,q,b) = (1+inc)c^s(g,q,b) \quad (8)$$

Where, inc is a specific constant called seller s's quality increasing factor.

B. Buyer Algorithms

The main part of buyer algorithms is estimation function and reputation modeling. Buyer b uses estimation function to evaluate the value of each bid. We have used two personality traits for buyers: openness and stingy. Openness of buyers means that they are interested to buy high quality and hedonic goods [8]. In addition, it is clear that stingy buyers focus on low price goods. We present the personality of buyer as follows:

$$P^b = [open_b, stingy_b] \quad open_b, stingy_b \in [0,1] \quad (9)$$

In which, $open_b$ means the score of openness of buyer b. $stingy_b$ means the score of stingy of buyer b.

Buyer b guesses the value of bids offered by each seller by using equation 10. The bid offered by seller is determined by (q_s, p_s).

$$E^b(q_s, p_s, s) = open_b * \frac{q_s}{q_{max}} - stingy_b * \frac{p_s}{p_{max}} \quad (10)$$

Where q_{max} the maximum quality of good g in the market is p_{max} is the maximum price for good with quality q_{max}. Buyer b estimates the value of all bids offered by different sellers and then selects the bid with highest value. We assume that selected seller is $\hat{s}$.

Buyer b announces the seller $\hat{s}$ and paying him. After receiving the good g from seller $\hat{s}$, buyer b examines the real quality of the good. Assume that buyer b find quality $\hat{q}$ for good g delivered by seller $\hat{s}$. Then, buyer b evaluates the reputation of seller $\hat{s}$. There two possibilities about the quality of good g:

1) If $\hat{q} \geq q_s$ then the reputation of seller $\hat{s}$ on quality is updated using reinforcement learning as follows:

$$r_q^b(s) = \begin{cases} r_q^b(s) + \mu_q(1 - r_q^b(s)) & if \quad r_q^b(s) \geq 0 \\ r_q^b(s) + \mu_q(1 + r_q^b(s)) & if \quad r_q^b(s) < 0 \end{cases} \quad (11)$$

Where, $r_q^b(s)$ means the reputation of seller s evaluated by buyer b. the default value of reputation of all sellers is equal to zero. $\hat{q}$ is the real quality which is examined by buyer b and q_s is the quality which seller s had offered. μ_q is a positive factor called the cooperation factor. μ_q is calculated as follows:

$$\mu_q = \begin{cases} (1 + open_b) * \frac{\hat{q} - q_s}{q_{max}} & if \quad \frac{\hat{q} - q_s}{q_{max}} > \mu_{min\_q} \\ \mu_{min\_q} & otherwise \end{cases} \quad (12)$$

That is, seller $\hat{s}$ offers good g with a quality greater than or equal to the value that buyer b demanded for quality of good g and therefore the reputation of seller $\hat{s}$ on quality is increased by equation (12) accordingly. Also ($1 + open_b$) has been considered to show that buyers who are more openness consider more reputation for sellers and vice versa. μ_{min_q} is a positive factor called minimum cooperation factor for quality.

2) If $\hat{q} < q_b$ then the reputation of seller $\hat{s}$ on quality is updated as follows:

$$r_q^b(s) = \begin{cases} r_q^b(s) + v_q(1 - r_q^b(s)) & if \quad r_q^b(s) \geq 0 \\ r_q^b(s) + v_q(1 + r_q^b(s)) & if \quad r_q^b(s) < 0 \end{cases} \quad (13)$$

Where, v_q is a negative factor called the non-cooperation factor. v_q is calculated as follows:

$$v_q = (1 + \overline{open_b}) * \frac{\hat{q} - q_b}{q_{max}} \quad (14)$$

In which, $\overline{open_b} = 1 - open_b$ and v_q is called the penalty factor. The value of v_q depends on the openness trait of buyer b. The greater value of openness trait causes the smaller value of v_q and vice versa. It means that buyers who are more openness, are more flexible in market and do not reduce the reputation of sellers, as much as low openness buyers.

Seller s is reputable for buyer b on quality iff $r_q^b(s) \geq \Theta_q^b$, where Θ_q^b is buyer b's reputable threshold on quality ($0 < \Theta_q^b < 1$). A seller s is considered as disreputable for buyer b on quality iff $r_q^b(s) \leq \theta_q^b$, where θ_q^b is buyer b's disreputable threshold on quality ($-1 < \theta_q^b < 0$). Therefore, buyer b focuses his trading on reputable sellers and do not communicate with disreputable sellers.

IV. EXPERIMENTAL RESULTS

We have implemented this model with aglet [9], [10] which is java based environment for building mobile and stationary agents. Our results show that stingy sellers obtain lower benefit rather than non-stingy sellers. Non-stingy seller agents consider more discount for buyer agents, therefore, they will be selected more time by buyer agents. In other word, the buyers dedicate higher value to their bids when they use estimate function to evaluate the value of each bid. Also, non- conscientious sellers sell their goods better than the other sellers for first time, But after some transactions their reputation tear down and buyers focus their trading on conscientious sellers. Results confirm that, finally, conscientious sellers obtain more satisfaction in comparison to non- conscientious sellers. Generally, non-stingy and conscientious sellers gain maximum benefit, and stingy and non-conscientious sellers obtain lowest benefit in the market. In addition, openness and non-stingy buyers purchase more expensive and high quality goods in the market relative to stingy and not openness buyers which focus their trading on cheap and low quality goods. We have tested this model by 100 seller agents and 10 buyers, in which, each buyer does 200 transactions in the market. Seller agents are categorized in four groups and buyer agents in 2 groups. Seller agents are divided into four groups as follows:

A. Group A consists of 25 seller agents. These are non-conscientious and stingy sellers.

B. Group B consists of 25 seller agents. These are conscientious and stingy sellers.

C. Group C consists of 25 seller agents. These are non-conscientious and non-stingy sellers.

D.   Group D consists of 25 seller agents. These are conscientious and non-stingy sellers.

We have assumed that all buyer agents model the reputation of sellers and they are non-stingy and openness. The results of the experiment confirm that personality influence the buyer and seller agents behavior in the market. This result is compatible with researches of marketing and personality. Table II, shows the total and average sales of different groups of sellers.

TABLE II: TOTAL AND AVERAGE NUMBEROF SALES BY FOUR GROUPS OF SELLERS

Group	A	B	C	D
Total # of sales of each group	250	412	250	1088
Average # of sales of each seller	10	16.48	10	43.52

As table II shows, the maximum number of sales made by group D which have conscientious and non-stingy personality. Group A and Group D, try to cheat the buyer agents and based on their personality which are non-conscientious, they offer high quality goods and deliver the goods with real quality. It means that they exaggerate about their goods without any responsibility. Results show that, buyers do not continue their communication with them and Each buyer purchases the good from them only once. The reputation of these sellers becomes lower that the threshold and they can not be selected again by buyers in their future purchases. Seller agents of group B made more sales rather than Group A and B. Although, these seller agents are stingy but they do not cheat the buyers and they offer the real quality of the goods.

For evaluating the buyer agents satisfaction, we made another test. In this test there are 50 seller agents. These agents are divided into two groups:

- Group A consists of 25 seller agents. These agents sell high quality and expensive goods.
- Group B consists of 25 seller agents. These agents sell low quality and low price goods.

Also, there are 50 buyer agents which each buyer agent does 50 purchases in the market. These agents are divided into two groups:

- Group A consists of 25 buyer agents. These agents are stingy and non-openness.
- Group B consists of 25 buyer agents. These agents are non-stingy and openness.

Table III shows that which group of buyers has focused on which group of sellers.

TABLE III: NUMBER OF PURCHASES MADE BY GROUPS OF BUYERS FROM SELLERS GROUP

Group of Buyer/Seller	A	B
Average purchases of Group I	14.32	35.68
Average purchases of Group II	38.12	11.88

We see that buyers of group I focus their trading on group B of sellers which offer high quality and expensive goods.

Also, buyers of group II focus their trading on Group A of sellers.

V.   CONCLUSION AND FUTURE WORK

In this paper we proposed a model based on personality for buyer and seller agents in agent-based e-marketplaces. We consider two personality traits for seller agents: stingy and conscientiousness. Stingy seller agents are the sellers who like money so much, and try to maximize their benefits. Therefore, these seller agents consider a little discount for buyers. Also, seller agents with personality trait conscientiousness are responsible, dutifulness and orderly. These sellers try to be trustful in the market. Their bids are compatible with the characteristics of their real goods. In addition, we use two personality traits for buyer agents: stingy and openness. Our results show that sellers with low score of stingy earn more benefits in comparison with high stingy sellers. Also, conscientious seller agents gain more reputation relative to conscienceless seller agents. On the other hand, buyer agents with high score of openness and low score of stingy purchase more new goods and more expensive goods relative to buyers with low score of openness and high score of stingy. We try to apply more personality traits of Big Five in electronic marketplace. Also, according to the nature of personality which is fuzzy, we will model the personality in fuzzy and specify the rules related to personality and buyer and seller behavior. The other important factor is culture which profoundly affects the buyer behavior in the market. Our future work concentrates on using culture in agent-based marketplaces.

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