THE IMPACT OF IRRATIONALITY ON NEGOTIATION STRATEGIES WITH INCOMPLETE INFORMATION

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ABSTRACT

Decision-making in negotiation with incomplete information, having an irrational part, is a complex problem. Inspired from research works aiming to analyze human behavior and those on social negotiation psychology, the integration of personality aspects, with the essential time parameter, is becoming necessary. For this purpose, first, one to one bargaining process, in which a buyer agent and a seller agent negotiate over single issue (price), is developed, where the basic behaviors based on time (Faratin *et al.*, 1998) and personality aspects (conciliatory, neutral, and aggressive) are suggested. Second, a cognitive approach, based on the five-factor model in personality (Fiske, 1949; Tupes and Christal, 1961; Norman, 1963), is suggested to control the resulting time-personality behaviors with incomplete information. In fact, the five factors are the extraversion, the agreeableness, the conscientiousness, the neuroticism, and the openness to experience. Afterwards, experimental environments and measures, allowing a set of experiments are detailed. Results, concerning time-personality behaviors, demonstrate that more increasing conciliatory aspects lead to increased agreement point (price) and decreased agreement time, and more increasing aggressive aspects lead to decreased agreement point and increased agreement time. Finally, from a study case, of three different personalities corresponding to three different cognitive orientations, experimental results illustrate the promising way of the suggested cognitive approach in the control of the time-personality behaviors.

KEYWORDS

Complex systems, decision-making, incomplete information, negotiation model, five-factor model in personality.

1. INTRODUCTION

This paper deals with social and cognitive negotiation behaviors for autonomous agents with incomplete information in order to find the adequate negotiation strategy in one to one negotiation which is a complex problem. Inspired from research works aiming to analyze human behavior and those on social negotiation psychology, the integration of psychological aspects of the agent personality, with the essential time parameter, is becoming necessary.

The aim of this paper, in a first part, is to analyze the psychological personality impacts (effects) on the negotiation particularly with regard to agreement point and agreement time. In effect, an important aspect of the analysis of the suggested negotiation model is to assess the variation consequences of different psychological agent characters (conciliatory, neutral, and aggressive) on the decisions that agents make.

In a second part, the aim of this paper is to suggest a cognitive approach, based on the five-factor model in personality (Fiske, 1949; Tupes and Christal, 1961; Norman, 1963), where the negotiation cognition is considered as mental orientation of the negotiator towards different cognitive orientations: Win-Lose orientation, Win-Win orientation, Lose-Win orientation, or No-Orientation.

Thus, in this paper, after related works in Section 2, a one to one bargaining process, in which a buyer agent and a seller agent negotiate over a single issue (price), is suggested in Section 3, where the negotiation behaviors are based on the time (Faratin *et al.*, 1998) and personality aspects. Then, a cognitive approach based on the five-factor model is suggested in Section 4 in order to control the resulting time-personality behaviors. Afterwards, experimental environments and measures, allowing a set of experiments, are detailed in Section 5. In first part of Section 6, experimental results of time-personality behaviors are analyzed with regard to time dependent behaviors for different time deadlines. In second part, the experimental results of the cognitive approach are given and analyzed from a study case of three different personalities.

2. RELATED WORKS

Interesting surveys on negotiation models in the Artificial Intelligence field are given in (Jennings, 2001; Gerding, 2000; Li, 2006). Elsewhere, Lomuscio *et al.* (Lomuscio *et al.*, 2003) identified the main parameters on which any automated negotiation depends and provided a classification scheme for negotiation models. The environment that a negotiator is situated in greatly impacts the course of negotiation actions. Instead of focusing on analyzing the strategy equilibrium and historical information as in game theory, Artificial Intelligence researchers are interested in designing adaptive negotiation agents, with incomplete information, to environment changes. Agents have incomplete and uncertain information about each other, and each agent's information (e.g., deadline, utility function, strategy, …) is its private knowledge.

An important research work has been developed by Faratin *et al.* (Faratin *et al.*, 1998) which devised a negotiation model that defines a range of strategies and behaviors for generating proposals based on time, resource, and behaviors of negotiators. By another way, in the research works developed aiming to analyze and describe human behavior in (Bales, 1950), twelve categories representing three major behavior parts have been defined: positive

socio-emotional part, a neutral task part, and negative socio-emotional part. In another side, in research works on the social negotiation psychology developed in (Rubin and Brown, 1975), the interpersonal orientation of a person has an influence on his negotiating behavior. It is predominantly concerned with the degree of a person's responsiveness. Responsive people are more co-operative and therefore expect positive results. Personality type should therefore be determined first to obtain the best results in negotiation. Thus, negotiation behaviors, in which characters such as conciliatory, neutral, or aggressive define a 'psychological' personality aspect of a negotiator, play an important role in negotiation.

Negotiations have received wide attention from distributed Artificial Intelligence community (Rosenschein and Zlotkin, 1994) and in general, any negotiation settings will have four different components (Wooldridge, 2002):

1) a negotiation set;
2) a protocol, legal proposals that agents can make ;
3) a collection of strategies, one for each agent;
4) agreement rule that determines reach agreement stopping negotiation.

By another way, the effects of personality factors in negotiation have been widely investigated by different researchers (Rubin and Brown, 1975; McAdams, 1992; Barry and Friedman, 1998; Ma, 2005). After decades, there is a global consensus on five-factor model in personality to be the most comprehensive, empirical, data-driven research findings in personality psychology (McAdams, 1992).

First articulated in the pioneering studies of Fiske (Fiske, 1949), Tupes and Christal (Tupes and Christal, 1961), and Norman (Norman, 1963), the five-factor model has become an increasingly influential framework during the last decades for organizing and understanding the universe of personality traits. In fact, this model is composed of five factors corresponding to five broad dimensions which are used to describe human personality (Neuroticism, Extraversion, Openness to experience, Agreeableness, and Conscientiousness).

3. ONE TO ONE (BILATERAL) NEGOTIATION

In this Section, the bargaining process, where buyer and seller negotiate, over a single issue is developed.

3.1 Negotiation Set

A negotiation set is the space (the range of issues over which an agreement must be reached) of possible proposals that agents can make. Let i represents the negotiating agents, in bilateral negotiation i $\in$ {buyer(b), seller(s)}, and j the issues, e.g., in single issue e.g., j = *price* the value of *price* acceptable is $x^i \in [\min^i, \max^i]$.

3.2 Negotiation Protocol

A protocol is the legal proposals in negotiation process, where each round consists of an offer from agent b at time t_1 and a counter-offer from an agent s at time t_2, i.e., round1 (t_1, t_2), round2 (t_3, t_4), … Thus, if agent b starts first, then it should offer in times $(t_1, t_3, t_5, …, t_{max}^b)$,

and agent s provides counter-offers in $(t_2, t_4, t_6, \ldots, t^s_{max})$, where t^b_{max} and t^s_{max} denote negotiation deadline for agents b and s, respectively.

3.3 Negotiation Behaviors

Time Dependent Behaviors: Time dependent functions are used as negotiation decision functions varying the acceptance value (price) for the offer depending on the remaining negotiation time t, i.e., depending on t and t^b_{max} for agent b and depending on t and t^s_{max} for agent s. Thus, proposal $x^b[t]$ to be offered by agent b and the one $x^s[t]$ to be offered by agent s at time t, with $0 <= t <= t^i_{max}$ belonging to [0, T - 1], are as follows. The proposal $x^s[t]$ with $0 <= t <= t^s_{max}$ belonging to [0, T - 1] is defined by Eq. (1), see (Faratin *et al.*, 1998; Li *et al.*, 2006) ; Boulware (B) for $\beta < 1$, Conceder (C) for $\beta > 1$, and Linear (L) for $\beta = 1$.

Parameter β ranges (Pruit, 1981; Raiffa, 1982) are defined as: $\beta 1 \in [20.00, 40.00]$ for Conceder (C), $\beta 2 = 1.00$ for Linear (L), $\beta 3 \in [0.01, 0.20]$ for Boulware (B).

$$x^s[t] = min^s + (1 - \alpha^s(t))(max^s - min^s) \quad \text{with} \quad \alpha^s(t) = K^s + (1 - K^s)(\frac{min(t, t^s_{max})}{t^s_{max}})^{\frac{1}{\beta}} . \quad (1)$$

Social and Cognitive Behaviors: The proposal $x^b[t]$ to be offered by agent b at time t, with $0 <= t <= t^b_{max}$ belonging to [0, T - 1], is defined using behaviors based on time and personality aspects detailed in Section 3. 4.

3.4 Negotiation Strategies

Time Dependent: During a negotiation *thread* (the sequence of rounds with offers and counter-offers in a two-party negotiation), a negotiation strategy based on time dependent behaviors defined in (Faratin *et al.*, 1998) consists to define the way in which such behaviors are used.

Time-Personality Dependent: These strategical behaviors integrate time and personality aspects and it is expected from such strategy the following hypothesis:

Hypothesis. The suggested strategy is expected to integrate time and personality aspects such that more increasing Conciliatory character leads to increasing agreement point and decreasing agreement time; and more increasing Aggressive character leads to decreasing agreement point and increasing agreement time.

Thus, such strategy is detailed from buyer point of view, where seller offers first. Note that, as the negotiation context is with incomplete information, the buyer doesn't know any information about the seller.

Step 1 (Computing First Offers). The agent proposal is obtained from Eq. (2) and Eq. (3) with the sum of weights equal to 1 and k^b_j a small positive constant, where xCon, αCon, and $\beta 1$ are obtained using Eq. (3) replacing xChar, αChar, and β, respectively, and similarly for xNeu, αNeu, $\beta 2$, and xAgg, αAgg, $\beta 3$.

$$x_j^b[t] = (W_{Con}^b[t] * xCon_j^b[t]) + (W_{Neu}^b[t] * xNeu_j^b[t]) + (W_{Agg}^b[t] * xAgg_j^b[t]), \tag{2}$$

$$xChar_j^b[t] = min_j^b + \alpha Char_j^b[t](max_j^b - min_j^b), \tag{3}$$

$$\text{where } \alpha Char_j^b[t] = k_j^b + (1-k_j^b)(\frac{min(t, t_{max}^b)^{\frac{1}{\beta}}}{t_{max}^b}).$$

Step 2 (*Predicting β of the Seller*). b predicts βs in Eq. (4) of s by Eq. (1).

$$\beta s = \frac{Ln\frac{t-1}{t_{max}^b}}{Ln\frac{\alpha_j^s[t]-k_j^b}{1-k_j^b}} \text{ where } \alpha_j^s(t_i) = \frac{x_j^s[t-1]-min_j^b}{x_j^s[0]-min_j^b}. \tag{4}$$

Step 3 (*Character To Change from Predicted β*). According to the result of the predicted βs, the buyer changes the corresponding character such as in Eq. (5). Then, If *βs > 1* Then Char = Con Changes, If *βs = 1* Then Char = Neu Changes, If *βs < 1* Then Char = Agg Changes:

$$NewxChar_j^b[t] = min_j^b + New\alpha Char_j^b[t](max_j^b - min_j^b),$$

$$New\alpha Char_j^b[t] = k_j^b + (1-k_j^b)(\frac{min(t, t_{max}^b)^{\frac{1}{\beta s}}}{t_{max}^b}). \tag{5}$$

Step 4 (*Computing DeltaCharacter*). According to the result of Step3 the buyer computes DeltaCharacter *DC^b as follows*: If Char To Change is Con, If Char To Change is Neu, If Char To Change is Agg:

$$DC^b = \frac{NewxChar_j^b[t] - xChar_j^b[t]}{xChar_j^b[t]}. \tag{6}$$

Step 5 (*Weight Updating*). According character to change, buyer updates: If Char To Change is Con (with wc=1, wn=-0.3, wa=-0.7), If Char To Change is Neu (with wc=-0.5, wn=1, wa=-0.5), If Char To Change is Agg (with wc=-0.7, wn=-0.3, wa=1):

$$W_{Con}^b[t] = W_{Con}^b[t-1] + wc * DC^b[t], \quad W_{Neu}^b[t] = W_{Neu}^b[t-1] + wn * DC^b[t],$$

$$W_{Agg}^b[t] = W_{Agg}^b[t-1] + wa * DC^b[t]. \tag{7}$$

Step 6 (*Computing the Proposal*). According the character to change, b updates:

$$x_j^b[t] = (W_{Con}^b[t] * xCon_j^b[t]) + (W_{Neu}^b[t] * xNeu_j^b[t]) + (W_{Agg}^b[t] * xAgg_j^b[t]) . \qquad (8)$$

3.5 Agreement Rule

An agreement rule determines the reach agreements stopping negotiation. Agent b accepts an offer $x^s[t]$ from agent s at time t if it is not worse than the offer he would submit in next step, i.e., only if Eq. (9) is satisfied. Similarly, s accepts an offer $x^b[t]$ from b at time t only if the relation given in Eq. (9) is satisfied.

$$\begin{cases} x^b(t+1) >= x^s(t) \\ t <= T_{max} \end{cases}, \quad \begin{cases} x^s(t+1) <= x^b(t) \\ t <= T_{max} \end{cases} . \qquad (9)$$

4. COGNITIVE APPROACH BASED ON THE FIVE-FACTOR MODEL

In this Section, the negotiation cognition is considered as a mental orientation of the negotiator towards Win-Lose orientation, Win-Win orientation, Lose-Win orientation, or No-Orientation. In the first orientation, agent has strong desire to win even with cost of opponent agent, while in the second orientation, the agent is trying to increase and maximize mutual utilities. In Lose-Win orientation, the agent sacrifices his own utility for some reasons like reputation, seeking trust, generosity, or to save time or resources. Such negotiation cognition can be deduced from the personality factors, using the five-factor model, of the negotiator in order to control the negotiation behaviors.

In this work, the negotiation cognition is exploited to determine, in each orientation case, the adequate weights of the linear combination of the time-personality behaviors (Conciliatory, Neutral, and Aggressive) used by each agent in order to affect the final outcome of negotiation.

The five-factors in personality are individual characteristics: affective, experiential, and motivational, as well as interpersonal (Barry and Friedman, 1998):

1) Extraversion, sociable, assertive, talkative, and active ;
2) Agreeableness, courteous, flexible, trusting, cooperative, and tolerant ;
3) Conscientiousness, careful, responsible, and organized ;
4) Neuroticism (emotional stability), anxious, depressed, worried, and insecure ;
5) Openness to experience, imaginative, curious, original, and broad-minded.

From the work developed in (Ma, 2005), it is concluded that Extraversion, Agreeableness, and Neuroticism are the three most important personality factors in the five-factor model that predict conflict styles. More, the value of each personality factor (Agreeableness: v_{Ag}^a, Extraversion: v_{Ex}^a, Openness to experience: v_{Oe}^a, Conscientiousness: v_{Co}^a, and Neuroticism: v_{Ne}^a), for agent a, is chosen from continuum 0 to 10. Then, based on their effects, the five

personality factors are grouped in three different sets leading to different negotiation cognitions:

   1) s1: Extraversion and Agreeableness factors leading to Win-Win or Lose-Win orientation ;

   2) s2: Neuroticism factor leading to Win-Lose orientation ;

   3) s3: Conscientiousness and Openness to experience factors leading to No-Orientation.

For each set, the corresponding personality value, of a negotiator, is computed as follows:

$$v_{s1}^a = \sqrt{v_{Ag}^a * v_{Ex}^a} \; , \; v_{s2}^a = v_{Ne}^a , v_{s3}^a = \sqrt{v_{Oe}^a * v_{Co}^a} \; . \tag{10}$$

Then, using these values, a value is computed for each cognitive orientation as follows:

$$V_{Win-Win}^a = V_{Utility}^a * \frac{v_{s1}^a}{\sum\limits_{i=1}^{i=3} v_{si}^a} \; , \; V_{Lose-Win}^a = V_{Social}^a * V_{Personal}^a * \frac{v_{s1}^a}{\sum\limits_{i=1}^{i=3} v_{si}^a} \; ,$$

$$V_{Win-Lose}^a = \frac{v_{s2}^a}{\sum\limits_{i=1}^{i=3} v_{si}^a} \; ,$$

$$V_{No-Orientation}^a = \frac{v_{s3}^a}{\sum\limits_{i=1}^{i=3} v_{si}^a} \; , \text{with} \; V_{Utility}^a + V_{Social}^a + V_{Personal}^a = 1 \; , \tag{11}$$

where:

   1) $V_{Utility}^a$ is the value attributed with regard to the intrinsic utility ;

   2) V_{Social}^a, is the value attributed with regard to social reasons (e.g., seeking for trust in market, seeking for mutual support, generosity or charity purposes, …) ;

   3) $V_{Personal}^a$ is the value attributed with regard to personal reasons (e.g., saving negotiation time, saving negotiation resources, …).

Then, the maximal value (among the cognitive orientation values) will determine the corresponding cognitive orientation. In the next step, the updating of weights for the linear combination, see Eq. (8), of time-personality behaviors (Conciliatory, Neutral, and Aggressive) will be chosen based on the negotiation cognition of the agent. In this model, in each state different combination sets of updating weights will be tested using a simple positive reinforcing method and the utility of the mid-point defined as follows:

$$Um_j^a = \frac{max_j^a + min_j^a}{2} \; . \tag{12}$$

If the agent has Win-Win orientation, then the set of weights will be chosen in the way to maximize both utilities. If the negotiation cognition of agent is oriented towards Lose-Win orientation, then the set of weights will be chosen in the way to maximizes opponent's agent utility. If the negotiation cognition of agent is oriented towards Win-Lose, then the set of coefficients will be chosen in the way to maximize agent's own utility. Finally, if the negotiation cognition of agent is No-orientation, then no change will be suggested.

5. EXPERIMENTS: ENVIRONMENTS AND MEASURES

In this Section, experimental environments and measures are presented and a set of experiments, carried out for different *short term* and *long term* deadlines of agents b and s, are presented.

5.1 Experimental Environments

Environments are defined in bargaining bilateral negotiation between buyer(b) and seller(s), in single issue negotiation j = *price*. The experimental environment is defined by the following variables [t_{max}^b , t_{max}^s , T_{max}, K^b, K^s, min^b, max^b, min^s, max^s], as defined in (Faratin *et al.*, 1998).

The negotiation interval (difference between minimum and maximum values of agents) for price is defined using: θ^i (length of the reservation interval for an agent i) and Φ (degree of intersection between the reservation intervals of the agents, ranging between 0 for full overlap and 0.99 for virtually no overlap). In the experimental environment: θ^i are randomly selected between the ranges [10, 30] for both agents, and $\Phi = 0$. The negotiation intervals are then computed, setting $min^b = 10$, by:

$$min^b = 10, \ max^b = min^b + \theta^b, \ min^s = \theta^b \Phi + min^b, \text{ and } max^s = min^s + \theta^s. \quad (13)$$

The analysis and evaluation of negotiation behaviors and strategies developed in (Wang and Chou, 2003), indicated that negotiation deadlines significantly influence the negotiation performance. From this, the experimental environment is defined from random selection of the round number within [10, 50] which corresponds to a random selection of T_{max} within [20, 100]. Initiator of an offer is randomly chosen because the agent which opens the negotiation fairs better, irrespective of whether agent is b or s.

5.2 Experimental Measures

To produce statistically meaningful results the precise set of environments is sampled from specified parameters in Section 5.1 and the environment number used is N = 200, in each experiment. This ensures that the probability of the sampled mean deviating by more than 0.01 from true mean is less than 0.05. The measures *Average Round Number (AR), Intrinsic Utility (U), Average Intrinsic Utility (AU), Utility Product (UP), Utility Difference (UD), Average*

Deal Number (AD), *Average Performance (AP)*, and *Final Performance (FP)* which are used in this work are detailed in (Bahrammirzaee *et al.*, 2013; Lee and Chang, 2008).

Average Round Number (AR): rounds to reach an agreement (deal), lengthy negotiation incurs penalties for resource consumption, thus shrinking utilities obtained by negotiators indirectly (Lee and Chang, 2008). Average round number AR is given in Eq. (14):

$$AR = \frac{\sum\limits_{n=1}^{N} R_D[n]}{N_D}, \tag{14}$$

where R_D is the number of rounds, for each environment with deal, and N_D is the number of environments with deals.

Intrinsic Utility (U):

$$U_j^b(i) = \frac{max_j^b - x_j^b(i)}{max_j^b - min_j^b} \ \text{ and } \ U_j^s(i) = \frac{x_j^s(i) - min_j^s}{max_j^s - min_j^s}. \tag{15}$$

Average Intrinsic Utility (AU):

$$AU_j^a(e) = \frac{\sum\limits_{e=1}^{E_j} U_j^a(e)}{E_j}, \tag{16}$$

where E_j is the total number of environments with deals, and $U_j^a(i)$ the utility of each agent, for each environment with deal.

Utility Product (UP): once an agreement is achieved, the product, of the utilities obtained by both participants UP_j is computed. This measure indicates the joint outcome:

$$UP_j = U_j^b.U_j^s \ \text{ and } \ AUP_j = \frac{\sum\limits_{e=1}^{E_j} \sqrt{UP_j(e)}}{E_j}. \tag{17}$$

Utility Difference (UD): once an agreement is achieved, the difference, of the utilities obtained by both participants UD_j is computed. This measure indicates the distance between both utilities:

$$UD_j = \left| U_j^b - U_j^b \right| \ \text{ and } \ AUD_j = \frac{\sum\limits_{e=1}^{E_j} UD_j(e)}{E_j}. \tag{18}$$

Average Deal Number (AD): the average deal number (AD_j^a) is obtained as follows:

$$AD_j = \frac{E_j}{N_j} \quad \text{with } 0 < AD_j < 1, \tag{19}$$

where E_j is the number of environments with deals, and N_j is the total number of environments for issue j.

Average Performance (AP): the Average Performance (AP_j^a) is an average evaluation measure implying the three experimental measures, i.e., the average intrinsic utility, the average time (round number), and the average deal number:

$$AP_j^a = \frac{AU_j^a(e) + (1 - \frac{At_j^a(e)}{At_{max}^a(e)}) + AD_j(e)}{3} \quad \text{with } At_{max}^a(e) = \frac{\sum_{e=1}^{E_j} t_{max}^a(e)}{E_j}, \tag{20}$$

where E_j is the number of environments with deals, and $At_{max}^a(e)$ is average negotiation deadline for E_j.

Final Performance (FP): the final performance measure (FP_j^a) is an average evaluation measure implying the three experimental measures, i.e., the average performance, the average utility difference, and the average utility product:

$$FP_j^a = \frac{AP_j^a + (1 - AUD_j) + AUP_j}{3}. \tag{21}$$

6. EXPERIMENTAL RESULTS

6.1 Time and Personality Experiment Results

In this Section, experimental results of the time-personality dependent behaviors are presented (varying curves), analyzed, and compared for different deadlines with regard to time dependent behaviors (constant curves) where both agent b and agent s use a Linear strategy.

Note that: since similar results are obtained, in each case Conciliatory, Neutral and Aggressive, also for short term deadlines, then only those related to long term deadlines are presented in this paper.

The results of presented in Fig. 1 concern the variation effects of the Conciliatory character of the buyer on negotiation behaviors. For long term deadlines, results demonstrate that more Conciliatory character is increasing implies more agreement point is increasing while more agreement time is decreasing.
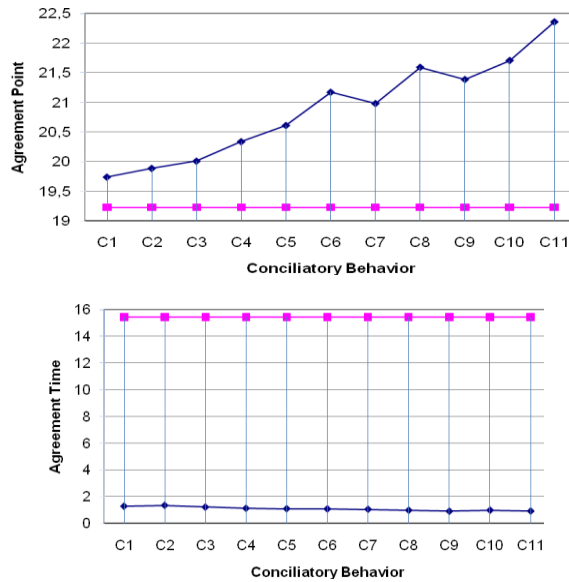
Figure 1. Conciliatory behaviors (long term deadlines): agreement point and agreement time.

The results presented in Fig. 2 concern the variation effects of the Neutral character of the buyer on the negotiation behaviors. For long term deadlines, results demonstrate that more Neutral character is increasing implies more agreement point is decreasing while more agreement time is increasing.
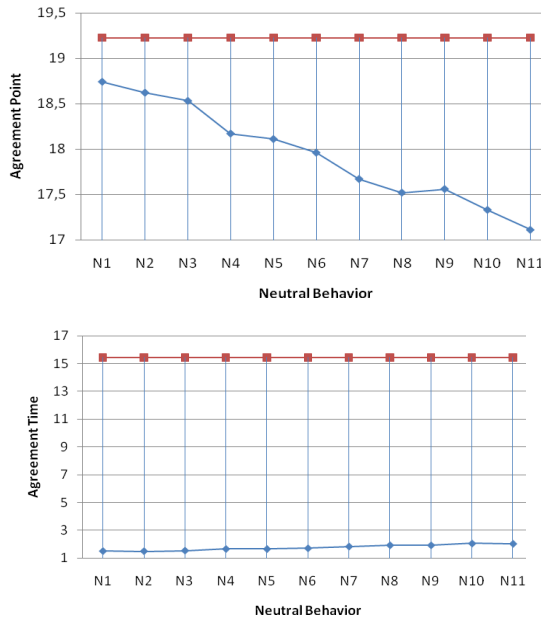

Figure 2. Neutral behaviors (long term deadlines): agreement point and agreement time.

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The results presented in Fig. 3 concern the variation effects of the Aggressive character of the buyer on negotiation behaviors. For long term deadlines, results demonstrate that more Aggressive character is increasing implies more agreement point is decreasing while more agreement time is increasing.
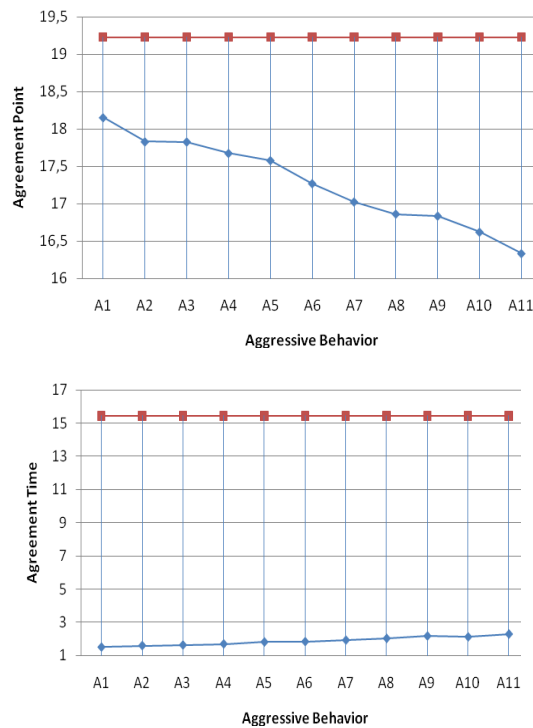

Figure 3. Aggressive behaviors (long term deadlines): agreement point and agreement time.

6.2 Cognitive Approach Experiment Results

In order to validate both online and offline effects of personality on negotiation outcomes we investigate, in this section, the effect of personality factors on final negotiation outcomes. To do so, three different personality cases corresponding to three different negotiators, Personality 1 (P-1), Personality 2 (P-2), Personality 3 (P-3), are defined as shown in Table 1.

Table 1. Three personality cases

Values / Cases	v_{Ag}^b	v_{Ex}^b	v_{Oe}^b	v_{Co}^b	v_{Ne}^b	$V_{Utility}^b$	V_{Social}^b	$V_{Personal}^b$
P-1	2	2	3	5	8	0.50	0.25	0.25
P-2	9	7	3	5	2	0.75	0.15	0.10
P-3	9	7	3	5	2	0.25	0.30	0.45

According to the first personality case, the value of Neuroticism factor (8) is the predominant factor value (largely more than other ones). Therefore, the agent is expected to have Win-Lose orientation which leads to high intrinsic utility and average performance. Then:

Hypothesis 1: The buyer agent with first personality gets more intrinsic utility and average performance comparing to negotiators with other personality cases but gets minimum final performance.

According to the second personality case, the values of Agreeableness (9) and Extraversion (7) factors are the predominant factor values. In addition, this agent gives more value to his utility (0.75) comparing to social (0.15) and personal (0.10) reasons. Therefore, the agent is expected to have Win-Win orientation which leads to high utility product, less utility difference and therefore, high final performance. Then:

Hypothesis 2: The buyer agent with the second personality gets more utility product, less utility difference and therefore, more final performance comparing to negotiators with other personality cases.

According to the third personality case, the values of Agreeableness (9) and Extraversion (7) factors are the predominant factor values. In addition, this agent gives more value to his social (0.30) and personal (0.45) reasons, comparing to his utility (0.25). Therefore, the agent is expected to have Lose-Win orientation which leads to less intrinsic utility for buyer agent, but less time to reach an agreement. Then:

Hypothesis 3: The buyer agent with third personality gets minimum intrinsic utility but needs less time to agreement comparing to negotiators with other personality cases. In addition, seller gets maximum intrinsic utility in this case comparing to two other cases.

Table 2. Cognitive approach results for three personality cases

Measures / Cases	U_j^b	U_j^s	t_j	UP_j	UD_j	AP_j^b	FP_j^b
P-1	0.4866	0.1800	24	0.0876	0.3066	0.5622	0.5171
P-2	0.3111	0.3555	20	0.1106	0.0443	0.5481	0.6121
P-3	0.2549	0.4117	19	0.1049	0.1567	0.5405	0.5692

The results presented in Table 2, show that the intrinsic utility of buyer agent in first personality case (0.4866) is, considerably, more than second and third cases (0.3111 and 0.2549). This high amount of intrinsic utility of first personality case, re-compensate the high amount of the time which he needs to reach to agreement (24) and, therefore, the average performance of first personality case (0.5622) is more than two other personality cases (0.5481 and 0.5405). However, he gets minimum final performance (0.5171) which is direct result of less utility product (0.0876) and more utility difference (0.3066) of first personality case, comparing to the other cases, supporting thus the Hypothesis 1.

According to Table 2, buyer agent with second personality case gets maximum utility product (0.1106), minimum utility difference (0.0443), and maximum final performance (0.6121), comparing to the other two cases, supporting thus the Hypothesis 2.

According to results presented in Table 2, the buyer agent with the third personality case has minimum intrinsic utility (0.2549) and average performance (0.5405), but needs less time to agree (19) comparing to the other personality cases. In addition, in this case, the intrinsic utility of seller (0.4117) is maximum comparing to the other cases, supporting thus the Hypothesis 3.

7. CONCLUSION

In this paper, first the time-personality dependent behaviors have been suggested for the negotiation process with *incomplete* information in one to one single issue (price) intending to find the adequate strategy. Results demonstrate, more increasing conciliatory aspects lead to increased agreement point (price) and decreased agreement time. On the other hand, more increasing aggressive aspects lead to decreased agreement point and increased agreement time.

Second, a cognitive approach is suggested, based on the five-factor model, where the negotiation cognition is considered as mental orientation of the negotiator towards different cognitive orientations: Win-Lose orientation, Win-Win orientation, Lose-Win orientation, or No-Orientation. From a study case, of three different personalities corresponding to three different cognitive orientations, experimental results illustrate the promising way (since the results illustrate a tendency towards the cognitive orientation deduced from the personality factors) of the suggested cognitive approach in the control of the time-personality behaviors. More, the important point in this suggested personality model is in its mediating effect on cognitive orientation. In other words, it affects the negotiation process and outcomes indirectly. Therefore, if, for example, the cognitive orientation of agent is Win-Win, it doesn't mean that the final output of negotiation will be also Win-Win. It means that based on his personality, the agent is more willing to have a tendency towards Win-Win results, since with incomplete information the final results will be attained also by the negotiation's environment and opponent's agent strategy.

Of course, such cognitive approach stills have challenging open questions with regard to the used personality model (five-factor model) which is not yet defined and stated completely according to the current psychology science advances, and with regard to its modeling from the psychology to computer science. Another important step is to integrate fuzzy reasoning to the suggested time-personality dependent behaviors (Richter *et al.*, 2009) and learning from interaction (Zeng and Sycara, 1997; Chohra, 2001).

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