Using different agent personalities to obtain different agent behaviors

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Abstract. Personality defines who we are, how we think and the way we behave and relate to others. Personality is defined as a set of individual characteristics that influence motivations, behaviors, and emotions when facing a particular circumstance. However, the personality is not usually taken into account when creating affective agent architectures that simulate human behavior. In this paper we show the results we have obtained executing agents with common actions but different behaviors due to their different personalities. We have used the *GenIA^3* architecture for affective BDI agents that we previously modified to allow the use of personality.

Keywords: Jason, personality, agent, behavior, emotion modelling.

1 Introduction

Personality is a construct that is used in psychology to explain the individual differences that constitute a person and allows him/her to differentiate from others. Personality influences the way in which emotional responses to specific stimuli occur [1]. As with many abstract concepts, there is no absolute consensus on what should be understood by personality. One of the most accepted definitions indicates that personality is the dynamic organization, within the individual, of the psychophysical systems responsible for their characteristic thought and behavior [2]. In general, we can say that personality is a set of distinctive features of a person that remain relatively stable over time and are invariant in different situations that explain the way in which a person behaves. Despite the importance of personality in human beings, it is not usually taken into account when models of affective agent are described. There are some works that use personality in agents, but always as a secondary affective component used to create more realistic agents [3]. However, personality can be very useful in modeling multi-agent systems since it allows different agents to show different behavior when faced with the same situation. In this work we analyze the results obtained by introducing the personality in the affective agents architecture *GenIA^3* [4].

2 Background and supporting theories

Personality is related to cognitive processes such as reasoning, memory [5], attention, decision making [6], the ability to solve problems or perception among others [7, 8]. For example, extraverted people tend to outperform introverted people in reaction-based tasks, while introverts tend to outperform extraverted people in processing and reasoning tasks. The personality also plays a very important role in emotions elicitation, in fact the personality can make the person more or less likely to experience certain types of emotions [9]. For example, the extraversion trait predisposes to experience a more positive affect more frequently and with greater intensity [10]. On the other hand, neuroticism predisposes to a negative affect as well as suffering from negative emotional states such as fear, anxiety, sadness, guilt or depression [11].

There are some previous works using the personality in multi-agent systems [12, 13]. But generally these works propose personality models dependent on the domain. We proposed a generic model of personality and we have introduced it in the *GenIA^3* architecture [14]. *GenIA^3* [4] is a general-purpose architecture for intelligent agents based on the *BDI* (Believe, Desire, Intention) model currently implemented in *Jason* [15]. *GenIA^3* facilitates the design of affective agents in a general way. Psychological and neurological theories have traditionally focused on the description of the characteristics and processes related to emotion and personality. Emotion-related processes are usually studied from a cognitive perspective and can be grouped into the generation of emotion, the experience of emotion, and the effects of emotion. The *GenIA^3* architecture includes the central processes of these three groups, as well as the processes of a traditional BDI agent architecture. Currently *GenIA^3* offers a default design that includes an appraisal process based on [16] and uses *Jason* as a base platform for multi-agent systems, the *five factor model* (FFM) [17] for representing the personality, and the *Pleasure-Arousal-Dominance model* (PAD) [18] for the mood. However, the *GenIA^3* architecture can be easily expanded and adapted to other psychological theories. For example, in [19] the management of expectations is incorporated into *GenIA^3*.
In *GenIA^3*, the selection of plans is done through two processes: The *Jason plan selection process* which returns the list of possible actions sorted according to their priority, and the *selecting affective actions process* which returns a list of possible affective plans sorted by priority. A *GenIA^3* affective plan is any plan including the annotation *affect__()* in the plan's label. This annotation is used to determine the affective state that the agent must have to select that plan.
In [14] a general personality model using personality profiles is proposed for the *GenIA^3* architecture. Personality profiles are very useful when modeling different behaviors grouping agents with a similar personality. Therefore, personality profiles allow the user to abstract from the different personality traits when modeling different behaviors. To define the plans according to the personalty profiles, the annotation for the plan label *personalityProfiles __* is proposed. Also the *GenIA^3* model for mood displacement has been modified in order to consider the effect of the personality [9] according to this formula:

$$personalityDisplacement = \left| \frac{pe}{npe} * e - \frac{ne}{nne} * n \right| \quad (1)$$

where *pe* is the number of active positive emotions (i.e. the positive emotions that have been calculated in the appraisal process), *ne* is the number of negative active emotions, and *npe* and *nne* represent the total number of positive and negative emotions respectively. Finally *e* and *n* are the levels of extraversion and neuroticism. This formula is bounded between zero and one because the personality traits are also bounded between zero and one.

3 Methodology and results

We have designed an experiment where sixty agents with different personalities played the blackjack card game. Each agent had a unique personality that made it different from the rest of the agents. We have created two personality profiles: Profile One consists of agents with low level of extraversion and high level of neuroticism, while Profile Two represents agents with high level of extraversion and low level of neuroticism:

`personality_profiles:`

$$\texttt{Profile\_One}(<0:1>, <0:1>, <0:0.5>, <0:1>, <0.5:1>).$$
$$\texttt{Profile\_Two}(<0:1>, <0:1>, <0.5:1>, <0:1>, <0:0.5>).$$

Each range of values represents a personality trait. The traits follow the order: openness, conscientiousness, extraversion, agreeableness, and neuroticism. So, for Profile One, the agents must have between 0 and 0.5 of extraversion and between 0.5 and 1 of neuroticism. And for Profile Two they should have between 0.5 and 1 of extraversion and between 0 and 0.5 of neuroticism. The rest of the traits are not significant in this experiment, so we have allowed them to have any value. There is a relationship between negative mood and risk aversion [20], and, as we have seen in section 2, there is also a relationship between neuroticism and negative moods and extraversion and positive moods. Keeping this in mind, we have created two different behaviors for each personality profile, and the plans of each profile were adapted to the risk aversion.

The agents had two main actions: hit or stand. We have divided these actions into eight plans, one for each group of action, mood (we consider two moods: positive and negative) and personality profile. In this way the agents who are in a certain profile will only take into consideration the actions of their profile. In this experiment the mood is represented by the set of PAD values. In order to model the plans we have used the plan labels presented in section 2. For example, the following label indicates that the plan is only activated for agents whose mood is sadness and belong to Profile One:

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@plan1[affect__(sadness), personalityProfiles__(Profile_One)]
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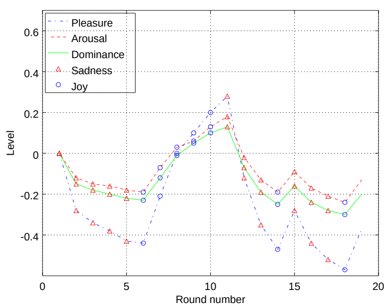
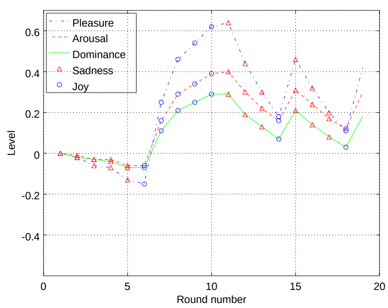
To facilitate the understanding of the experiment, we have only used two emotions: sadness and joy. Each emotion has a different effect on mood. Through the mapping used by [21] we have determined that the theoretical point of sadness emotion in the PAD space is [-0.63, -0.27, -0.33] and for the joy is [+0.76, +0.48, +0.35]. To control the generation of emotions, agents played eighteen rounds: seven have a winning result and eleven have a losing result. Winning a game causes the joy emotion in the agent, while losing a game causes the sadness emotion. Therefore, we have alternated the two emotions over time and checked the mood evolution for the two different profiles. All agents start with the same mood value: zero for the three dimensions. This decision allows to easily compare the evolution of the mood in both personality profiles.

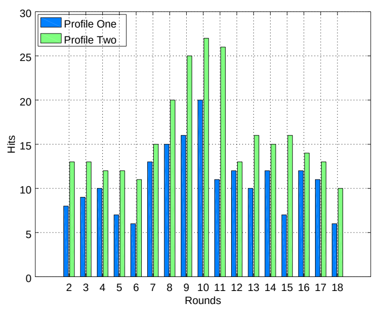
We have run the experiment with the sixty agents and we have stored the mood for each round. Figures 1.a and 1.b show the average evolution of the mood in each profile. We can see that players with low levels of extraversion and high levels of neuroticism, which correspond to Profile One, have obtained lower levels in the three dimensions of the mood than the agents in Profile Two with high levels of extraversion and low levels of neuroticism. It is also observed that Profile One has a downward trend, while Profile Two shows an upward trend. Another thing that we can appreciate, is that Profile One suffers a higher decrease when it loses than Profile Two. This can be seen for example in Figures 1.a and 1.b, where it is observed that from round eleven to fourteen, whose result is losing, agents with Profile One suffer a greater decrease than agents with Profile Two.



(a) Mood evolution in Profile One.



(b) Mood evolution in Profile Two.



(c) Total number of hit actions taken by agents in each round.

Fig. 1.

In the same way, it is observed that the agents that are classified in Profile Two suffer a greater increase in their mood when a positive emotion arrives. For example, from round six to seven, there is a greater increase in Profile Two than in Profile One. And the same happens with negative emotions and the level of neuroticism, as it can be seen in rounds eleven to twelve. Agents with a higher level of neuroticism suffer a greater decrease in all dimensions than those with a low level of extraversion. We note that when analyzing the evolution of the mood in the two profiles, the mood does not always increase and decrease in the same average. This is because *GenIA^3* soften the mood shift when the mood approaches to the theoretical point of emotion. Another important observation is that the final mood is different for each profile in all dimensions of the PAD. This is consistent with the psychological theories that determine the individual differences produced by the personality when dealing with a particular emotion.

We have also analyzed the behavior of the agents when they made the decision to hit or to stand. Figure 1.c shows that agents in Profile One select the hit action less times than the agents in Profile Two. This is because the mood in the Profile One generally has a negative level. But the most important conclusion of this graph is that there is no fixed pattern of behavior for all agents. That is, not all agents take the same decisions in all the rounds. There are some agents who hit and others who do not. This is because each agent has a different personality, therefore, a different behavior and mood. Without the personality, the thirty agents of each profile would have performed the same action in each round, since they would all have the same mood and the same situation.

4 Discussion

Personality is a very important factor when understanding individual differences that affect the way we perceive the environment and emotions. Personality affects our mood and our cognitive processes. However, personality is not usually taken into account when modeling affective agents. In this work we have analyzed the results obtained by including the personality in a multi-agent system. We have modified the cognitive processes of the agents allowing the personality to influence the reasoning and decision making processes, influencing the way in which the agents select the plans. In this way, the personality allows different behaviors in the agents. By the use of personality, the simulation of human behavior is improved and *GenIA^3* is more consistent with the psychological theories that determine the individual differences produced by the personality when dealing with a particular emotion [9, 22]. Further experiments must be performed to validate these results with humans. If we want to improve the human-machine interaction using affective characteristics, we have to take into account the personality. In this way, there are a lot of open issues, for example, how does personality affect the temporal dynamics of the affective state process?, how can we use the personality in multi-agent systems to improve the quality of memory? or how can be used the different personality traits to determine the level of empathy of the agents?

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