Anger and Aggressive Behavior in Agent Simulation

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Abstract

Emotions, especially negative ones, have a significant influence on the human performance and intelligent behavior. Anger also is more likely to affect decision-making and behaving because anger includes most states of effective emotions, such as stress or fear. Besides, personality has a leading role in affecting the states of emotions in specific situations. The purpose of this paper is simulation of the anger emotion and personality in intelligent agents. To do this, the dimensions of personality related to anger are linked to aggression by a fuzzy expert system as a new way of implementing an intelligent emotional agent. The knowledge base of this expert system contains fuzzy rules obtained from a decision tables and facts obtained from ontology.

1. INTRODUCTION

Simulation of human behavior is one of the most important and remarkable subjects in fields of research and creating applications [Ghasem-Aghae et al. 2005]. In the case of design of agents, believability and naturalness should be considered along with user expectations and the quality of interaction. To augment these specifications of an agent, it has to express emotion and exhibit personality in a coherent manner [Malatesta et al. 2007]. Personality traits are considered as constant tendencies to get into corresponding emotional states and thus are a major source of emotional and behavioral consistency [Malatesta et al. 2007]. Having emotions like humans helps the agent to perceive situations more efficiently and to make decisions more realistically and thus to perform more effectively [Ören and Ghasem-Aghaee 2003].

Several implementations of agents with emotions exist. Elliot proposed Affective Reasoner (AR) that models a multi-agent world and gives simple affective life to agents in the form of elementary emotions, emotion-induced actions and elementary personalities [Elliott 1992]. Rizzo proposed a model to design believable agents that exhibit behaviors influenced by their own personalities [Rizzo 1998]. El-Nasr and Skubic described a fuzzy emotional agent to make decisions in a mobile robot based on three negative emotions: anger, pain, and fear [M. Seif El-Nasr and Skubic 1998]. El-Nasr also proposed a new computational model of emotions that can be incorporated into intelligent agents and other complex, interactive programs which use a fuzzy-logic representation to map events and observations to emotional states [Magy Seif El-Nasr et al. 2000]. Schmidt presented the framework of the PECS (Physic, Emotion, Cognition, and Social Status) architecture where a system-theoretical methodology is used for specifying agents' personality traits [Schmidt 2002]. Mehdi Dastani and Ch. Mayer provided the syntax and semantics of a simplified version of a logic-based agent-oriented programming language to implement agents with emotions [Dastani and Meyer 2006].

In this article, we focus on modeling affective virtual characters in order to exhibit different amounts of anger and different behaviors under similar situations depending on their personality traits—including a personality variable and personality dimensions—and current mood. We use the term personality dimensions when referring to the constructs identified by the five-factor model but the term personality variables when referring to the measured constructs available in the empirical literature on aggressive behavior [Bettencourt et al. 2006]. Since studies of behaviorists and psychologists about human personalities are based on personality theories on their own field of studies, and also because these two groups do not completely agree about these theories; there are a lot of debates about personality. As an example, psychologists like McCrae use the term “Anger” to demonstrate an emotional experienced under a circumstance like frustration, but Behaviorists like Bettencourt apply the term “Anger” to explain a personality trait defined as the inclination to feel anger more deeply, more often, and for a longer period of time than others. There are two major viewpoints toward personality. To exemplify, McCrae and Costa have formulated the Five-Factor Theory to explain how traits’

factors play roles in personality. These factors result from statistical practices used to examine how different personality traits are interrelated in humans [Srivastava 2009], but behaviorists, like Bandura, not only do not confirm this theory but also criticize it. For example, Bandura believes that the Five-Factor super-traits are too general, have incongruous facets and lack appropriate factors to explain the job performance [Bandura 1999]. In our current work, we have attempted to find out the lost chain between behaviorists' and psychologists' theories to figure out more comprehensive and rational explanation of personality traits and to model them more realistically. We think that the person should have a constant personality trait, but his personality facets must be changed in different situations to create different sensation and, in result, to form different behaviors. Therefore, we devise a set of rules for each personality trait which modifies the values of personality facets to depict how one person with a specific personality will behave in a certain situation.

Section 2 defines the emotion, personality, and behavior issues. Section 3 represents design of an agent with anger emotion and aggressive behavior. In section 4, the implementation of the agent is showed. Section 5 states the conclusion and future works.

2. PSYCHOLOGICAL BASES

2.1. Emotions

Whereas emotions are abstract concepts, there are a great number of definitions and explanations for them. Unabridged (v 1.1) Dictionary defines emotions as an affective state of consciousness in which one experiences joy, sorrow, fear, hate, and so on, as distinguished from cognitive and volitional states of consciousness. Emotions are usually associated with certain physiological changes, as increased heartbeat or respiration, and often visible expression, as crying or shaking ["Emotion" 2009]. Consciousness is assumed as the essence of phenomenal and functional mental life. It provides the basic information for thinking about events, planning, behaving on the basis of one's thinking and actions [Bandura 1999].

According to Frijda, most stimuli that bring out emotions are a result of previous experience or cognitive activities [Frijda 1987]. Emotions are created by groups of thoughts in which a stirring event is related to one or more concern of the individual. In other words, emotions result from match or mismatch between events and concerns [Leshan 1999].

Since emotions are elaborated concepts, it is problematic to implement all of them beside each other. So, primarily, we identify our working area and pick one emotion to simulate separately. To do this, we have chosen the anger emotion. Basic emotions are happiness, fear, sadness, surprise, anger, and disgust [Frijda 1987]. Anger is the most important one due to the fact that the fear, the sadness, the disgust and even maybe the surprise emotion are positively related to anger. In addition, Kassinove considers anger as an organism's motor performance and maintains that anger plays an effective role in cognition and decision-making [Kassinove and Tafrate 2002]. Besides, El-Nasr, in the FLAME model, verifies the superiority of negative emotions over the positive ones [Magy Seif El-Nasr et al. 2000].

2.1.1. Anger

Ortony et al. consider anger as a compound emotion as the combination of distress and reproach [Ortony et al. 1988]. Anger is an intricate issue that cannot be described solely by outer conditions; it virtually requires the interaction of varied inner states [M. Seif El-Nasr and Skubic 1998]. Thus, anger usually is known regarding its experience and its behavioral outcomes. Anger can be experienced in response to sadness, fear or painful, negative experiences. Therefore, anger could be defined as a reaction of anxiety and antagonism which arises because of threats, or injustices [Hartley 2002]. In other words, anger is experienced in the state of frustration, attribution of blame, and a failure of control or power over events. Frustration-aggression theory describes anger as a drive state, in which an organism is hindered in its efforts to achieve a goal, causes arousal of aggressive energy [Levinson et al. 1999]. Anger brings biological reactions, such as increase in blood pressure, respiration, heart rate, perspiration, and increasing of blood sugar, all of which result to make the organism excited. In this manner, it is the whole constellation of responses that defines anger; no single division of this procedure alone is a certain sign of anger by taking account of individual and cultural differences in the experience and expression of anger [Kassinove and Tafrate 2002]. Anger is typically expressed outward and, mostly, is presented by shouting, making nasty or sardonic remarks [Corsini 1999]. Moreover, cognition and anger are inextricably connected. Anger results from the cognitive assessment that an external stimulus is enticing [Bettencourt et al. 2006]. The events, which lead to anger, do not contain emotional values; this is just the way that one perceives the environment that brings about biological changes [Luhn 1992]. In addition to the level of stress, the reaction of anger is related to other factors. When anger is low, most of the time, people suppress anger in the middle of a crowd of people; suppressed anger will create depression as negative emotions that are turned inwards instead of being directed towards outside events [Hartley 2002]. However, when anger is high, the person has a propensity to fight with other people around him. Anger has a tendency to amplify itself. If an individual express anger at another angry person, both are likely to become even more hostile because outbursts can be frightening and

escalate anger thoughts [Luhn 1992]. The cycle of negative thoughts can lead to painful feelings of tension, frustration, culpability, sorrow, inadequacy [Hartley 2002]. Here is the cycle of anger:

1. Anger is triggered by an event.
2. Anger thoughts are developed.
3. The next behaviors are based on the angry thoughts.
4. Anger is fed and breeds a destructive series of angry thoughts and actions.

Sometimes, the experience of anger is fleeting. The person may burst out a great intensity of anger. Then, as suddenly as it came, it is over. On the other hand, some people seethe for days, months, or even years. They have a kind of ruminative anger that is truly lasting and problematic. Initially, anger may be low, moderate, or high.

2.2. Personality

Personality models are needed; since people with different personalities may react differently to same situations. Personality is that patterns of characteristics thoughts, feelings and behaviors that distinguish one person from another and that persist over time and situation [Phares 1991]. It is the sum of biologically based and learnt behavior which makes the person response to environmental stimuli exclusively [Heinström 2003]. In other words, personality is an interior assortment of traits giving individuals an inclination to act and experience themselves in steady, permanent ways [Corsini 1999]. From psychology research, there are many personality models that consist of a set of dimensions, where every dimension is a specific property. OCEAN model [Costa 1992] with five dimensions, or traits (Openness, Conscientiousness, Extraversion, Agreeableness, Neuroticism) –each having six facets– is used in this paper. Ören and Ghasem-Aghaee formulated –based on OCEAN model– personality representation processable in fuzzy logic for human behavior simulation [Ghasem-Aghaee and Ören 2003; Ören and Ghasem-Aghaee 2003]. Later it was suggested to use the dynamic personality model as a personality filter to take into account the variability of personality traits [Ghasem-Aghaee and Ören 2007; Seck et al. 2005].

The neuroticism and agreeableness dimensions appear to be particularly associated with aggression. As well, anger is most strongly and positively related to neuroticism and low agreeableness (i.e., Antagonism) [Bettencourt et al. 2006].

The agreeableness dimension describes the attitude directed toward interpersonal relationships and the needs of others. The facets of agreeableness consist of trust, straightforwardness, altruism, compliance, modesty, and tender-mindedness. Antagonistic people (who are low in agreeableness) tend to oppose, to show aggression, or to reprimand others. Thus, they tend to mistrust and have a low regard for others, and they act in ways to exclude or snub those who are perceived as disliked or inferior. Finally, antagonistic people may lack emotional expression and be unattached interpersonally [Bettencourt et al. 2006].

The neuroticism dimension is characterized by a tendency to experience negative affectivity and psychological distress. The facets of neuroticism include worry, anger, discouragement, vulnerability, self-consciousness, and impulsiveness. Neurotic individuals are incompetent in coping with stress and are tending to get involved with sophistic thoughts [Bettencourt et al. 2006].

2.3. Behavior

The thought processes of a person reflect his emotional response, and lead to particular kinds of behavior [Hartley 2002]. The behavior is purposeful and conscious actions, reactions, and interactions in response to stimuli, including discernible activities, and unconscious processes [Corsini 1999]. Five aspects are assumed to be involved with an action, and to affect the way of the action, its features, and results. These aspects are perception, cognition, emotion, volition, and physical or motor performance [Leshan 1999].

2.4. Anger and Aggressive behaviors

Aggression is defined as any behavior intended to harm another individual, and aggressive behavior is usually engendered by provocations, which are aversive actions, or stressful situations [Bettencourt et al. 2006]. Particular personality variables seem to prognosticate different patterns of aggressive behavior. A variety of aggression related personality variables is based on two separate factors. The first factor represents the impulsive and affective dimension of aggression. The second factor represents the social cognitive dimension of aggression [Bettencourt et al. 2006].

Personality variables associated with the aggressive behavior are: aggressiveness, irritability, anger, emotional susceptibility, narcissism, type A personality, dissipation /rumination, and impulsivity [Bettencourt et al. 2006].

According to the definitions of these behavioral traits of personality, some similarities can be found between these personality traits and personality types described by five-factor model namely, challenger, flexible, responsive, and reactive. To illustrate, challenger is defined as a "tough-minded, narcissistic, or authoritarian" person [Ören and Ghasem-Aghaee 2003].

3. DESIGN OF ANGER AGENT

Firstly, the factors of the five-factor model are stable in a long period of life and also they are the same for

everyone around the world [Howard and Howard 2004]. Secondly, issues without new or exceptional states, which could be determined inductively from past data, should be modeled by rules [Pal and Shiu 2004]. So, in this study, by taking into account of these two facts, we have simulated the anger emotion by a frame-based expert system to try a new way of simulating an anger agent. Anger agent is implemented by an interactive application to give users the capability of stimulating and analyzing anger and personality in agent.

After specifying the working area, we deployed ontology to design the agent. In this state, we determined objects (frames) Person and Environment, their properties (slots and facets), and relationships between them. The sketch of this design is showed in Figure 1.

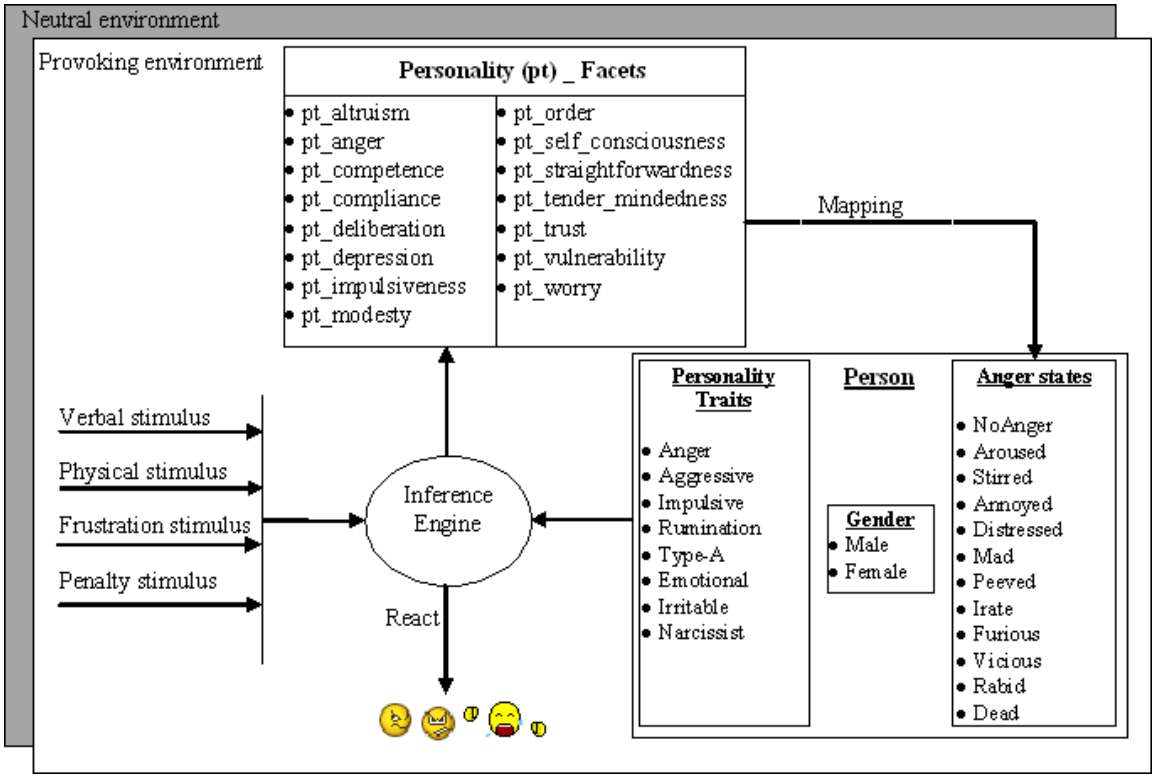

Figure 1. The model of the Anger Agent

According to the empirical literature there are four types of provocation: Physical (shock, hit), Verbal (insulted by another, evaluated poorly, or yelled at), Frustration (difficult puzzle, preventing the achievement of a desired goal), and Penalty (monetary or point penalty) [Bettencourt et al. 2006]. Hence, we have considered four types of stimulus in the agent's environment. With respect to definitions of personality traits, 15 from 30 facets of Five-Factor model are related to the anger emotion, included all six facets of neuroticism and agreeableness plus competence, order, and deliberation of conscientiousness.

Then, fuzzy variables and rules need to be determined. We divide: (1) *states of anger* into twelve states of NoAnger, Aroused, Stirred, Annoyed, etc. (depicted in Figure 2); (2) *intensities of stimuli* into four levels of NoImpact, LowImpact, MediumImpact, and HighImpact; (3) *degrees of personality facets* into three degrees of Low, Medium, and High; and then (4) represent all of them by triangular membership functions. We also use Mamdani's max-min method [Mamdani and Assilian 1975] with centroid defuzzification to obtain values of the variables.

Since psychologists and behaviorists maintain their statements by exemplifying a number of particular situations and do not suggest any specific behavioral rule by taking account of situations, in which a person is, we employ Case-Based reasoning's methods to set up required rules. In particular, ID3 algorithm inspired us how to analyze these examples to figure out what factors are most effective in personality and behavior, and what their priorities are. Therefore, we have followed the ID3's steps to determine that which decision table should contain which factors (e.g. Table 1).

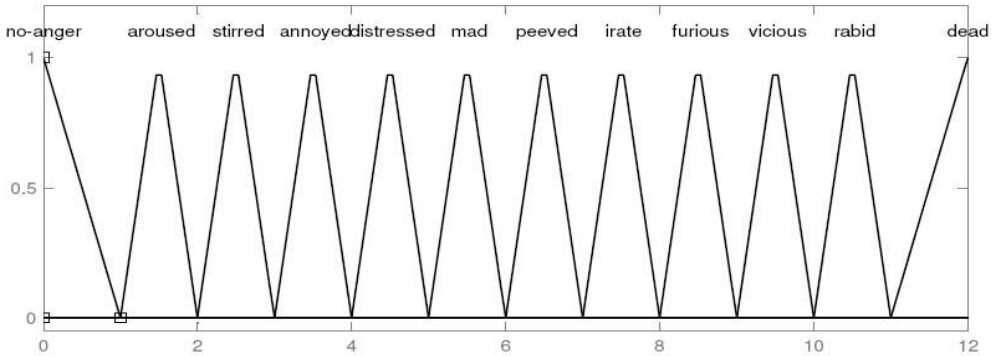

Figure 2: States of anger fuzzy set

By this method, one hundred and ninety two rules have been determined to estimate personality's facets according to the personality trait, the intensity of the stimulus, and the kinds of the stimulus and the environment. Table 1 shows that when a person with a specific personality (i.e. irritability), in an environment (i.e. provoking), perceives a stimulus (i.e. punch) with different intensities, how the personality facets change according to each intensity of the stimulus. A sample rule from Table 1 is showed as following:

IF		PersonalityTrait	=	Aggressive
	AND	KindofEnvironment	=	Provoking
	AND	KindofStimulus	=	Physical
	AND	IntensityofStimulus	=	HighImpact
THEN		PT_Worry	=	High
	AND	PT_Anger	=	Extremely High
	AND	PT_Competence	=	Low or Medium
	…	…	…	…

Table 1: Rules to estimate personality facets

IF part	Personality Trait	Irritability			
	Environment Kind	Provoking			
	Stimulus Kind	Physical			
	Stimulus Intensity	No Impact	Low Impact	Medium Impact	High Impact
THEN part (Personality facets)	PT_Worry	More or less Low	Intensify Medium	Very Medium	High
	PT_Anger	Plus Medium	Above Medium	Plus High	Extremely High
	PT_Competence	Nothing	Nothing and Low	Low	Low or Medium
	…	…	…	…	…

The factor "Anger Degree" is obtained when the personality facets are evaluated. Then, "Anger Degree" is mapped to one of the "States of Anger" in Figure 2. The factor "AngerState", along with the "gender" factor has been used in behavioral rules to determine the pattern of the agent's behaviors, such as:

IF		PersonalityTrait	=	Aggressive
	AND	Gender	=	Male
	AND	AngerState	=	Stirred
THEN		FaceImage	=	MadFace.gif
	AND	React	=	Shoving
	…	…	…	…

There are twelve behavioral rules for each personality in specific states of anger; thus, there are also one hundred and ninety two behavioral rules. However, when the application runs, the agent is initialized, and the expert system's engine only places fifty rules—twenty four personality rules, twelve behavior rules, related to the agent's personality trait and gender, and fourteen rules to identify the AngerState—in the working memory.

4. IMPLEMENTATION

The Anger Agent's software is implemented in the Java environment with a graphical interface. We have used the JavaBeans properties to define slots of the agent's frame, and to enable frames to call one another. We have also considered a timer and a decreasing coefficient to simulate decaying of anger which is similar

to FLAME model [Magy Seif El-Nasr et al. 2000]. At the end of each cycle, a feedback procedure reduces the agent's Anger Degree, and reflects it back to the system. We have applied the Exponential Distribution Function, and considered a specific λ—that λ is in range of $0.3<\lambda<0.55$—for each personality trait.

To construct this application, we have applied three modules which can be deduced from Figure 1. The first one is the Environment module which represents the agent's circumstances and enables users to create a specific event as a stimulus to the agent with a desired intensity. The second is the Person module. This module, in fact, portrays a person with a constant personality. It contains all of the specifications needed to make the agent capable of acting like a human, such as personality facets, gender, and mood. The last module is a fuzzy inference engine. Its duty is to assess the values of the Person object's facets and to conclude which behavior should be taken due to perceived stimuli from the Environment object.

Moreover, this application has three interfaces, two of which represent the Person; through the first interface, the user can specify the agent's name, personality trait and gender (Figure 3). The second interface exhibits the Environment which can also be considered as the agent's sensor because stimuli perceived by the Person are notified by it. In addition, this interface provides users with a brief explanation of the Person's personality by which the users can have better understanding of the system. The user identifies the kind of environment—Neutral or Provoking—and stimulus—Physical, Verbal, Frustration, or Penalty—and the intensity of stimulus—from 0 to 100—by this form; then, he stimulates the agent by the identified input through this sensor (Figure 4-right interface). In the third interface all details about the Person such as its anger state, all values of personality facets, and reaction can be observed (Figure 4-left interface). As you can see in Figure 4, Gender and Personality trait was the user's entries from the first interface, Mood always is bad because of the anger emotion, and all other information in this panel, such as values of personality facets or anger degree, are the outputs of this application. There is also a colored square in this interface whose colors as well as face image are corresponding of states' anger of the person.

Figure 3: The user's information interface

5. CONCLUSION

Psychologists have studied and described emotions in two different ways; personality psychologists, like Costa and McCrae (1992), theorized about emotions on the basis of personality dimensions while behaviorists, like Bandura (1999), considered personality variables to explain emotions. Since emotions are the most efficacious factors in decision making and performance, applying emotions in applications to achieve more reasonable results and optimum performance has become a noticeable issue in the field of Artificial Intelligence. Anger has a major portion of this effect. Hence, in this article, we attempted to simulate the anger emotion, and concluded that there is a connection between psychological and behavioral theories, so in order to shed light on this lost link, we developed tables, like Table 1, to figure out rules that explain this relationship. Therefore, we present a new model of implementing anger which is more elaborate than others due to encompassing advantages of previous studies plus fitting psychologists' points of view about personality traits into behaviorists' views to implement affiliated behaviors in particular situations by designating fuzzy values for facets of personality dimensions. Moreover, we point out the fact that this approach is simpler and faster than methods implemented with computational algorithms because of existence of a limited number of particular rules in working memory—only thirty six rules—used for each specific personality trait that makes searching a solution for input cases easier and faster.

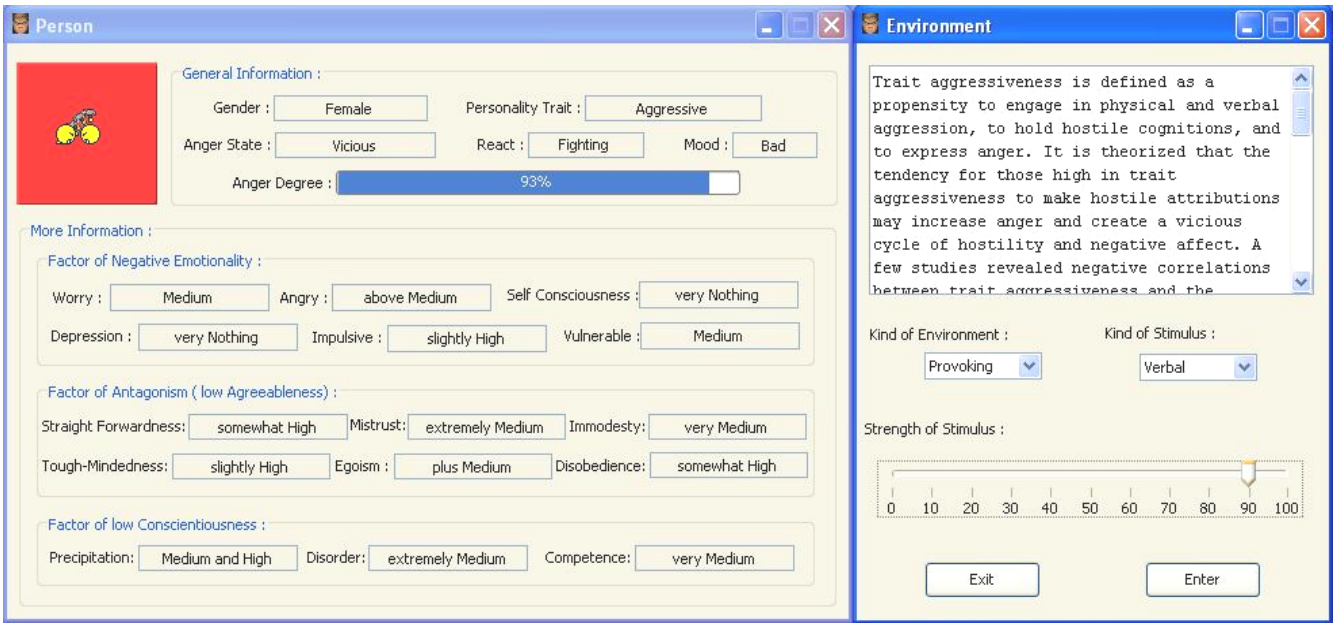

Figure 4: An outlook of the software environment's interface: By which the user stimulates the agent in the particular environment in the right interface, and through of the left interface which all detail information about the agent and its personality along with a general explanation about the personality trait can be seen

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Biography

Dr. Nasser Ghasem-Aghaee is a co-founder of Sheikhbahaee University of Higher Education in Isfahan, Iran, as well as Professor in the Department of Computer Engineering at both the Isfahan University and Sheikhbahaee University. He received his Ph.D. & M.Sc. degrees from the University of Bradford and Georgia Tech. respectively. In 1993-1994 and 2002- 2003, he has been a visiting Professor at the Ottawa Center of the McLeod Institute for Simulation Sciences at the School of Information Technology and Engineering of the University of Ottawa. He has been active in simulation since 1984. His research interests are modeling and simulation, cognitive simulation including simulation of human behaviour by fuzzy agents, agents with dynamic personality and emotions, artificial intelligence, expert systems, fuzzy logic, object-oriented analysis and design, multi-agent systems and their applications. He published more than 100 documents in Journals and Conferences.
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