Personality, Emotion and Mood Simulation in Decision Making

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Abstract. In this paper is proposed the integration of personality, emotion and mood aspects for a group of participants in a decision-making negotiation process. The aim is to simulate the participant behavior in that scenario. The personality is modeled through the OCEAN five-factor model of personality (Openness, Conscientiousness, Extraversion, Agreeableness and Negative emotionality). The emotion model applied to the participants is the OCC (Ortony, Clore and Collins) that defines several criteria representing the human emotional structure. In order to integrate personality and emotion is used the pleasure-arousal-dominance (PAD) model of mood.

1 Introduction

Nowadays groups are used to make decisions about some subject of interest for the organization or community in which they are involved. The scope of such decisions can be diverse. It can be related to economic or political affairs like, for instance, the acquisition of new military equipment. But it can also be a trivial decision making as the choice about a holiday destination by a group of friends. Therefore, it may be claimed that Group Decision Support Systems (GDSS) have emerged as the factor that makes the difference one assess the behavior and performance of different computational systems in different applications domains, with a particular focus on

socialization. Groups of individuals have access to more information and more resources what will (probably) allow reaching "better" and quicker decisions. However working in group has also some difficulties associated, e.g. time consuming; high costs; improper use of group dynamics and incomplete tasks analysis.

Many of this will take a new dimension if we consider that they will be resolved by a group of individuals, each one with a different type of personality. Our society is characterized by the use of groups to make decisions about some subject of interest for the organization in which they are involved. If we predict the personality of our adversaries we could find the best arguments to be used in the negotiation process in order to reach a consensus or a better decision in the shortest possible time. Emotions have proven effects on cognitive processes such as action selection, learning, memory, motivation and planning. Our emotions both motivate our decisions and have impact on our actions.

The use of multi-agent systems is very suitable to simulate the behaviour of groups of people working together and, in particular, to group decision making modelling, once it caters for individual modelling, flexibility and data distribution [1][2]. Various interaction and decision mechanisms for automated negotiation have been proposed and studied. Approaches to automated negotiation can be classified in three categories [3], namely game theoretic, heuristic and argumentation based. We think that an argumentation-based approach is the most adequate for group decision-making, since agents can justify possible choices and convince other elements of the group about the best or worst alternatives.

Agent Based simulation is considered an important tool in a broad range of areas e.g. individual decision making (what if scenarios), e-commerce (to simulate the buyers and sellers behaviour), crisis situations (e.g. simulate fire combat), traffic simulation, military training, entertainment (e.g. movies).

According to the architecture that we are proposing we intend to give support to decision makers in both of the aspects identified by Zachary and Ryder [4], namely supporting them in a specific decision situation and giving them training facilities in order to acquire skills and knowledge to be used in a real decision group meeting. We claim that agent based simulation can be used with success in both tasks.

In our multi-agent architecture model [5] we have two different types of agents: the Facilitator agent and the Participant agent. The Facilitator agent is responsible for the meeting in its organization (e.g. decision problem and alternatives definition). During the meeting, the Facilitator agent will coordinate all the processes and, at the end, will report the results of the meeting to the participants involved. The Participant Agent will be described in detail in the next section.

In this work is presented a new argumentation process with the inclusion of personality using the Five-Factor Model of Personality (FFM) [6] and emotion using the OCC model [7]. The mood of the participants will also be represented by the use of the PAD mood space [8].

2 Participant Agent

The participant agent has a very important role in the group decision support system assisting the participant of the meeting. This agent represents the user in the virtual world and is intended to have the same personality and to make the same decision as if it were the real participant user. For that reason we will present the architecture and a detailed view of all the component parts. The architecture is divided in three layers: the knowledge layer, the interaction layer and the reasoning layer (Figure 1).
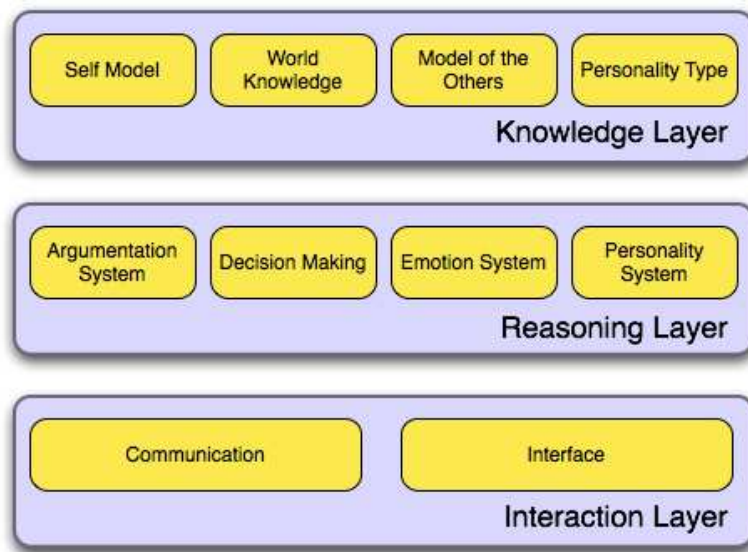

Figure 1 - Participant Agent Architecture

2.1 Knowledge Layer

In the knowledge layer the agent has information about the environment where he is situated, about the profile of the other participant's agents that compose the meeting group, and regarding its own preferences and goals (its own profile).

The personality is defined in this layer through the Big Five Inventory (BFI) [9] and available publicly to be used by the other opponent participants.

The information in the knowledge layer has some kind of uncertainty [11] and will be made more accurate along the time through interactions done by the agent. The credibility of the participants and the perception that one user has about the others will be refined along he time in the "Model of the Others" component.

A database of profiles and history with the group's model is maintained and this model is built incrementally during the different interactions with the system. The community should be persistent because it is necessary to have information about previous group decision making processes, focusing credibility, reputation and past behaviours of other participants.

2.2   Reasoning Layer

The agent must be able to reason based on complete or incomplete information. In this layer the reasoning mechanism is based on the information available in the knowledge layer and on the messages received from other agents through the interaction layer. The reasoning mechanism will determine the behaviour of the agent and allow the acquisition of new knowledge, essentially based on previous experiences.

The reasoning layer contains four major modules:

- The argumentation system – that is responsible for the arguments generation. This component will generate persuasive arguments, which are more related with the internal emotional state of the agent, and about what he thinks from others' profiles (including the emotional state).
- The decision-making module – will support agents in the choice of the preferred alternative. The preferred alternatives are in the self-model of the participant agent, being filtered and sorted by this component.
- The emotional system [1]– will generate emotions and moods, affecting the choice of the arguments to send to the other participants, the evaluation of the received arguments and the final decision. The emotions that will be simulated in our system are those identified in the reviewed version of the OCC (Ortony, Clore and Collins) model: joy, hope, relief, pride, gratitude, love, distress, fear, disappointment remorse, anger and hate.
- The personality system – will identify the personality of the other participants in order to find the best strategy for the argumentation on the negotiation process based on the FFM of personality [12].

2.3   Interaction Layer

The interaction layer is responsible for the communication with other agents and by the interface with the user of the group decision-making system. All the messages received will be sorted, decoded and sent to the right layer based on their internal data. The knowledge that the participant user has about his actions and of the others are obtained through this layer.

3   Personality Type Identification

In order to make agents more human-like and to increase their flexibility to argument and to reach agreements in the negotiation process, we updated the previous agent participant model [13] and included the personality system component.

Personality plays an important role on the behaviors of the participants in a decision meeting. "Behaviors are influenced by personalities so that personality refers to sets of predictive behaviors by which people are recognized and indentified [14]".

The personality is divided in 30 attributes, each one called a personality facet. The personality facets are clustered in five groups, called personality factors or traits. The

five-factor model of personality is best known as OCEAN: Openess, Conscientiousness, Extraversion, Agreeableness, and Negative Emotionality; and is the most widely accepted model of personality [15]. The identification of the personality of each participant its classified using the BFI [9] and fit in one of the themes based on the FFM. A theme is a characteristic personality pattern that reflects the combined effect of two or more factors or facets [16].

There are several types of themes based on the FFM for each set of personality types. For the decision making area the themes that could be applied are: the conflict styles and the decision style. We select the conflict style because we will be using the personality in the negotiation process where many disagreements and conflicts arise. The conflict styles theme uses only four of the five factors of the model that are: the agreeableness, the conscientiousness, the extraversion and the negative emotionality.

4 Emotional System

Our participant agent is composed by an emotional system, which, beside other tasks, will generate emotions. Those emotions are the identified in the revised version of the OCC model [7]: joy, hope, relief, pride and gratitude, love, distress, fear, disappointment, remorse, anger and hate.

Table 1: Revised OCC Model

Positive reaction	Appraised events	Categories
Joy	Because something good happened	Undifferentiated
Hope	About the possibility of something good happening	Goal-based
Relief	Because a feared bad thing didn't happen	
Pride	About a self-initiated praiseworthy act	Standards-based
Gratitude	About an other-initiated praiseworthy act	
Love	Because a person finds someone or something appealing	Taste-based
Negative reactions	**Appraised events**	**Categories**
Distress	Because something bad happened	Undifferentiated
Fear	About the possibility of something bad happening	Goal-based
Disappointment	Because a hoped-for good thing didn't happen	
Remorse	About a self-initiated blameworthy act	Standards-based
Anger	About an other-initiated blameworthy act	
Hate	Because a person finds someone or something unappealing	Taste-based

The agent emotional state (i.e. mood) is also calculated in this module based on the emotions generated. To model mood we use Albert Mehrabian's pleasure (P), arousal (A) and dominance (D) trait which form the PAD space. These traits are independent

of each other and form a 3D space. The pleasure level relates to the emotional state's positivity or negativity, arousal shows the level of physical activity and mental alertness, and dominance indicates the feeling of control. These trait's values lie between the positive (+1) and negative (-1) ends of each dimension. Mehrabian defined eight mood types based on the combinations of negative (-) and positive (+) values for each dimension: pleasant (+P), unpleasant (-P); aroused (A+), unaroused (A-); and dominant (D+), submissive (D-). Table 2 shows all the mood types defined by Mehrabian.

Table 2: Mehrabian Mood Types

Trait combination	Mood type
+P+A+D	Exuberant
-P-A-D	Bored
+P+A-D	Dependent
-P-A+D	Disdainful
+P-A+D	Relaxed
-P+A-D	Anxious
+P-A-D	Docile
-P+A+D	Hostile

Because Mehrabian also defines the relationship between the OCEAN personality traits and the PAD space, we can translate the 5D personality vector (P) into a corresponding PAD space mood point [8]. Considering an OCEAN personality (O, C, E, A, N) the initial mood is calculated in the following way:

InitialMood = (P, A, D)
  $P = 0.59 * A + 0.19 * N + 0.21 * E$
  $A = 0.57 * N + 0.30 * A + 0.15 * O$
  $D = 0.60 * E + 0.32 * A + 0.25 * O + 0.17 * C$

When the system updates the emotional state, the mood point shifts in the 3D PAD space. The change is based on which emotion is activated. Mehrabian defined more than 240 emotions although as we use the revised version of the OCC model that is composed only by 12 we made a correlation between both models [10]. Table 3 shows our correlation between OCC emotions and PAD space [8].

Table 3: Correlation between OCC emotions and the PAD space

Emotion	Pleasure	Arousal	Dominance	Mood type
Joy	0.40	0.20	0.10	+P+A+D Exuberant
Hope	0.20	0.20	-0.10	+P+A-D Dependent
Relief	0.20	-0.30	0.40	+P-A+D Relaxed
Pride	0.40	0.30	0.30	+P+A+D Exuberant
Gratitude	0.40	0.20	-0.30	+P+A-D Dependent

Love	0.30	0.10	0.20	+P+A+D Exuberant
Distress	-0.40	-0.20	-0.50	-P-A-D Bored
Fear	-0.64	0.60	-0.43	-P+A-D Anxious
Disappointment	-0.30	0.10	-0.40	-P+A-D Anxious
Remorse	-0.30	0.10	0.60	-P+A-D Anxious
Anger	-0.51	0.59	0.25	-P+A+D Hostile
Hate	-0.60	0.60	0.30	-P+A+D Hostile

Each participant agent has a model of the other agents, in particular the information about the other agent's mood. This model deals with incomplete information and the existence of explicit negation. Some of the properties that characterize the agent model are: gratitude debts, benevolence, and credibility.

Although the emotional component is based on the OCC model, with the inclusion of mood, it overcomes one of the major critics that usually is pointed out to this model: OCC model does not handle the treatment of past interactions and past emotions.

5 Negotiation Process

For the negotiation the process is divided in three stages: Pre-Negotiation, where the participants should gather and analyse information and set objectives; In-Negotiation: where the participants should analyse, argue, persuade others and achieve and agreement if possible; Post-Negotiation: where the participants should confirm the agreement and review the negotiation. For each one of these stages different emotions are generated. Next we will explain the emotions that are generated for the stages.

5.1 Pre-Negotiation

In the pre-negotiation the agent first does an analysis on the adversaries and next establishes the objectives for the negotiation.

The adversaries' analysis generates taste-based emotions:
- Love – Because a person finds someone or something appealing;
- Hate – Because a person finds someone or something unappealing.

Establishing the objectives to the negotiation generates goal-based emotions:
- Hope – About the possibility of something good happening;
- Fear – About the possibility of something bad happening.

5.2 In-Negotiation

The aim of the meeting is to achieve an outcome which both sides can accept. The in-negotiation is the most important process because it is where the proposals are

exchanged. During the in-negotiation process, participant agents may exchange the following locutions: request, refuse, accept, request with argument.

- Request (AgPi, AgPj, α, arg) - in this case agent AgPi is asking agent AgPj to perform action α, the parameter arg may be void and in that case it is a request without argument or may have one of the arguments specified at the end of this section.
- Accept (AgPj, AgPi, α) - in this case agent AgPj is telling agent AgPi that it accepts its request to perform α.
- Refuse (AgPj, AgPi, α) - in this case agent AgPj is telling agent AgPi that it cannot accept its request to perform α.

The purpose of the participant agent is to assist the user. For example, in Figure 2, it is possible to see the argumentation protocol for two agents. This is the simplest scenario, because in real world situations, group decision making involves more than two agents and, at the same time AgP1 is trying to persuade AgP2, that agent may be involved in other persuasion dialogues with other group members.
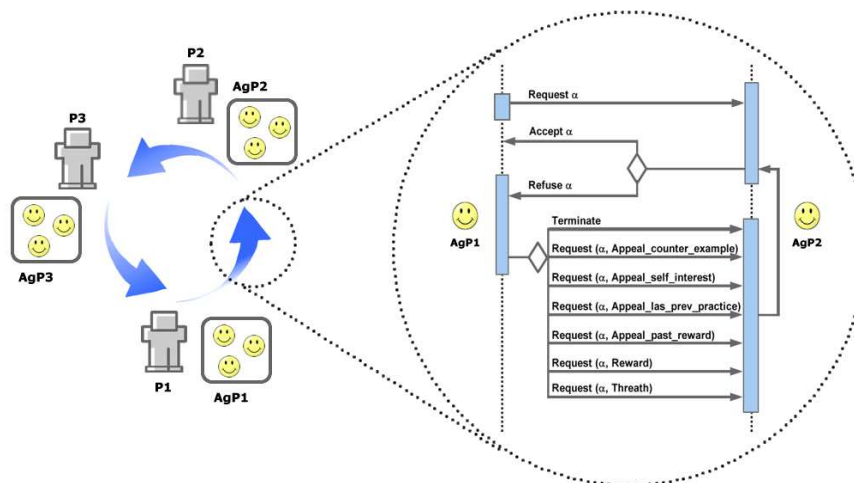
Figure 2 - Argumentation Protocol

Argument nature and type can vary, however six types of arguments are assumed to have persuasive force in human based negotiations [17][7]: threats; promise of a future reward; appeal to past reward; appeal to counter-example; appeal to prevailing practice; and appeal to self interest [18]. These are the arguments that agents will use to persuade each other. This selection of arguments is compatible with the power relations identified in the political model: reward, coercive, referent, and legitimate [19][20].

In the past has been made a study of the impact personality had in the argumentation process [16]. To summarise the previous study of the impacts that personality FFM factors have on each argument intended to be used in the negotiation process, a table

(Table 4) was created to show all the permitted arguments. This table and the study is only applied to the personalities of the conflict styles theme.

Table 4: Possible arguments to each personality on the conflicts style

	Appeal to Self Interest	Appeal to prevailing practice	Appeal to counter example	Appeal to past reward	Reward	Threat
Negotiator	Yes	Yes	Yes	Yes	Yes	Yes
Aggressor	Yes	No	No	Yes	Yes	Yes
Submissive	No	No	Yes	No	No	No
Avoider	No	Yes	Yes	No	No	Yes

This work is also intended to consider emotion in the argumentation process. The arguments defined by Sarit Kraus [18] have a natural order of argument power to be sent: Appeal to self-interest, Appeal to prevailing practice, Appeal to counter example, Appeal to past reward, Reward, Threat. To generate the emotions we divided the arguments in appeals, rewards and threats.

A. Appeals

Appeals generate undifferentiated emotions:
- Joy – Because something good happened;
- Distress – Because something bad happened.

B. Rewards

Rewards generate standards-based and undifferentiated emotions. When the actions are related to whom is making the reward it generates standard-based emotions, when it is an response to an action it generates undifferentiated emotions.

Rewards sent:
- Pride - About a self-initiated praiseworthy act (emotion generated when the reward is sent to a counterpart);
- Joy – Because something good happened (emotion generated in the response to the reward sent);
- Distress – Because something bad happened (emotion generated in the response to the reward sent).

Rewards received
- Remorse - About an other-initiated praiseworthy act.

C. Threats

Threats generate standard-based and undifferentiated emotions. When the actions are related to whom is making the threat it generates standard-based emotions when it is an response to an action it generates undifferentiated emotions.

Threats sent
- Remorse - About an other-initiated praiseworthy act;
- Joy – Because something good happened (emotion generated in the response to the reward sent);
- Distress – Because something bad happened (emotion generated in the response to the reward sent).

Threats received
- Hate - About an other-initiated blameworthy act.

In order to exemplify this process for our multi-agent model [5] a diagram is presented (Figure 3) with two participant agents (AgP1 and AgP2) for a general meeting. To explain the diagram we are going to describe the numbered circles (1, 2, 3, 4, 5 and 6).
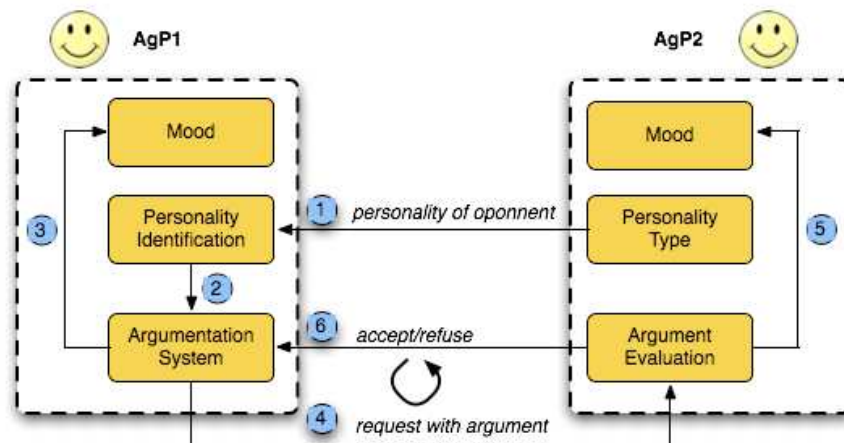
Figure 3 – Argumentation dialog using personality, emotion and mood

In the diagram is possible to see two agents (AgP1 and AgP2) where AgP1 would like to make a request to AgP2. The more important steps that occur in our model are the following:
1. AgP1 receives the personality of AgP2 and proceeds to the personality identification component. In this component the received information verified to see if is compatible with previous negotiations with this participant;
2. The personality type is sent to the argumentation system;
3. The argumentation system updates the mood component based on the emotions generated;
4. The argumentation system component selects the possible set of arguments and starts making a request with the weaker argument;

5. AgP2 receives the request evaluates it, the emotions are generated and updates his mood;
6. AgP2 accepts or refuses the request.

Several iterations can occur in steps 3 to 6, depending on the set of possible arguments to be sent to AgP2.

5.3 Post-Negotiation

The negotiation should be reviewed by all the members to analyze the conclusion and verify if the objectives established at the beginning (Pre-Negotiation) were achieved.

The analysis of the negotiation generates goal-based emotions:
- Relief – Because a feared bad thing didn't happen;
- Disappointment – Because a hoped-for good thing did not happen.

6 Conclusion

This work proposes the inclusion of the personality and emotion in the negotiation process of an argument-based decision-making. In spite of using two different components to model personality and emotion we start using the PAD mood space, which is able to support OCEAN and OCC models. Is proposed as well a mapping of the OCC emotions to the PAD mood space. Each person is unique and has different reactions to the exchanged arguments. Many times a disagreement arises because of the way we began arguing and not because of the content. Our main goal on a decision meeting is to reach consensus where everyone can be satisfied about the result. The principal determinant of a member's degree of satisfaction with his or her group's decision is the extent to which the member agrees with the decision [21].

Each participant agent represents a group decision member. This representation facilitates the simulation of persons with different personalities. The discussion process between group members (agents) is made through the exchange of persuasive arguments, built around the same premises stated before.

As future work we intend to make more use of the PAD mood space instead of the personality themes. Personality themes are of a great use in the beginning of the argumentation process but the mood space in the long term is better because it can add more information.

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