Emotional Computing - Modelling and Sociological Aspects

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Abstract: The human emotion is a key to social interaction and the fundament of a humane society. One aspect of emotion research within the domain of artificial intelligence is the capability of artificial emotional agents to show adequate emotions which make them part of a society. As an example scenario, the public goods game (PGG) is chosen. In a public goods game with punishment option free riders will likely be forced by the other community members to follow the rules. The punishing action is not free of costs but still punishment takes place if the players are not scheduled to meet again in a game constellation. This makes the punishment action 'altruistic'. As a conclusion from experiments with humans, emotions are identified as reasons for the phenomenon of altruistic punishment. The research work presented here includes a model of emotion based upon the emotion theory by Ortony, Clore and Collins. The focus of the paper is the design of the emotion joy within this model applied to an artificial emotional agent in the PGG.

Introduction

Sociology includes the research on the motivation and the reasons for social acts. The sociology of emotion is a part of this research and the approach discussed in this paper addresses emotion models in this field. The public goods game (PGG) serves as a scenario in which humans are assumed to show emotion driven decisions. An agent model which eventually shows similar behaviour may therefore claim to be emotional. It is a very limited scenario and only a few decisions are required, but emotional behaviour can be nicely imitated by an artificial player agent. So the scenario serves as a first step validation for our computer model of emotion.

The PGG Scenario

The public goods game consists of four players. Each of them gets a certain amount of money and has to decide about the amount to put into a common project. The total amount of money invested in this project is paid interest on and redistributed among the players in equal shares. The optimal strategy according to the game theory is to

invest nothing, yet, the best decision for the players as a group is different. This game is iterated and a punishment option is added. Therefore a player can decide to punish a “free rider”. According to Fehr and Gächter [1] the punishment option leads to higher average payments. It has an educational effect, but it also costs the punisher a certain amount of money. A certain rationality of this action can be found by considering the fact that the game is iterated and the behaviour of the free rider is changed by the punishment. In their experiments, Fehr and Gächter [1] repeat the game with the condition that the group composition changes from period to period. Since only others may benefit from the punishment, the punishment decision becomes *altruistic*. The experiments showed a significant correlation between the emotion *anger* and the punishment decisions.

Mapping PGG on OCC

A popular model which follows the appraisal theory of emotion is the model by Ortony, Clore and Collins (OCC) [2]. This model specifies 22 emotion categories and groups them in three dimensions: *goal relevant events*, *actions of agents* and *aspects of objects*. In the presented model, first the intensities and desirabilities of the predefined eliciting events or actions are derived from the scenario.

In our approach, the OCC model is combined with a personality model. The personality model provides non-linear transfer functions which map current mood and elicitor intensity to emotion intensity.

Which *events* do we have to consider? It’s the publication of the payments and punishments. The *goal* of a player can either be to *maximise* his or her own income or get *higher* income than others. As ‘well-being’-emotions *joy* and *distress* are generated. The elicitor’s intensity is given by a distance function comparing result and goal. The agent records previously played games and derives the *likelihood* of future game situations. For each action, a likelihood of the future situations is computed. The emotions *fear* and *hope* depend on the likelihood and desirability of the future situation.

Which *actions* of agents do we have to consider? The elicitor intensity is related to the praiseworthiness of the action, which depends on the moral standards of the agent.

As consequence of one moral standard, paying the full amount may be considered praiseworthy since it is beneficial for all. On the other hand, paying nothing whereas all others pay 20 may lead to joy but probably also to shame. As consequences for the game, shame and distress (high punishment) leads to remorse and as a consequence to higher compliance in the next round.

As last consideration, the *attraction* of another player, caused by his or her behaviour in earlier games, may play a role in the decision. For a closer description of the overall architecture see [3].

Modelling Joy

As mentioned above, the OCC model is combined with a personality model in order to generate adequate emotions. The core part of this model is the mood, which can be seen as a filter for emotion elicitors. The mood control functions are provided by the personality model as well as the standards, goals and eliciting functions. If we (superficially) consider moods as 'long term emotions', we can apply Russel's model based on arousal and valence [4] to describe the current mood in two dimensions. Obviously, the same event causes different reactions if the agent is in a *satisfied* mood (positive valence, rather low arousal) and in *alarmed* mood (neutral valence, high arousal). Using valence and arousal, a family of parametric functions is defined. These functions serve as filters for the emotion elicitor.

Figure 1 shows an example of two abstract moods with their filter function for joy.

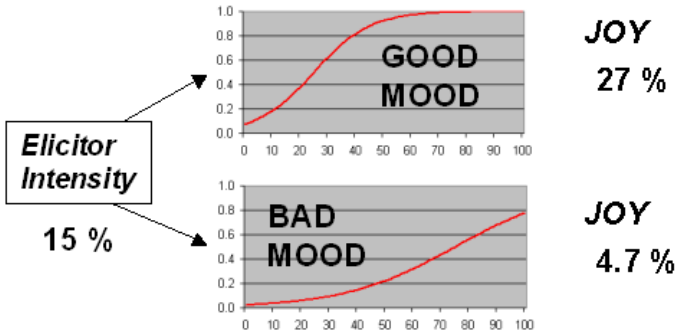

Figure 1: Simplified example for a mood filter function

Of course there is no common model for these filters which may be valid for all humans; in fact there are individual dispositions for emotions. The model we introduce provides the necessary parameters, not yet the values which eventually complete the model of a specific person.

What is joy in the PGG? According to OCC it is an emotion belonging to "well-being" which is influenced by the expectation of the consequences of events for oneself. For the PGG situation we identify four different elicitors of joy:

1. "**gain**": 20 Euro are paid each round, so any outcome which is higher than that is success and leads to joy.
2. "**competition**": How do the other players perform? If one's own outcome is higher than the others' – using average outcome as a basis – then joy is a consequence.
3. "**expectation**": According to experience, the player has a certain expectation on the outcome. If this is achieved or even surpassed, he or she may feel joy.
4. "**increase**": As in economy, the performance is always compared to the past and (only) an increased performance means success. The same can be applied to this scenario.

Since the intensity of the four elicitors depends on the situation as well as on the personality of the player, an individual elicitor function F_e is introduced as part of the personality model. The four elicitors all contribute to the emotion of joy. Again, their influence depends on the personality model includes a weight factor W_e for each elicitor. The intensity of joy, eventually, is computed by the normalized weighted sum. However, this is not yet the displayed emotion, but its current elicitation which subsequently is filtered by the current mood.

How does the mood evolve? As mood is a long term feeling, the current emotional elicitors also have an influence on it. Again, the mood span and the shifting speed (in both dimensions, valence and arousal) depend on the personality. Consequently, the personality model we propose carries individual mood stimulation functions to integrate this. In a first approach, parametric sigmoid functions are used.

To sum up, the personality model consists of the elicitation functions F_e, the individual weights W_e, and the mood influence functions $f_{emotion}$ and stores the current mood represented by valence and arousal.

$$elicitation_{joy} = \frac{1}{\sum_e W_e} \cdot \sum_e (F_e(situation) \cdot W_e)$$

$$joy = f_{joy}(valence, arousal, elicitation_{joy})$$

Conclusion

Currently, the model is built up for the emotion of joy in the PGG. General functional tests are done, yet, for a validation of the emotional model at least the prospect based emotions as well as the compound emotions consisting of attribution and well-being need to be integrated. Current work focuses on a validation environment and on the integration of these components.

References

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