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Biologically Inspired Cognitive Architectures II:
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A Pragmatic Approach to Implementation of Emotional Intelligence in Machines

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Abstract

By this paper we would like to open a discussion on the need of Emotional Intelligence as a feature in machines interacting with humans. However, we restrain from making a statement about the need of emotional experience in machines. We argue that providing machines computable means for processing emotions is a practical need requiring implementation of a set of abilities included in the Emotional Intelligence Framework. We introduce our methods and present the results of some of the first experiments we performed in this matter.

Introduction: A(de)ffective Computing

The man-made rapid evolution of machines made computers equal or even surpass humans in features, like processing speed[1] or memory capacity[2]. Still, whether machines could obtain more human-like features, like emotions, remains a riddle. A motivation for Affective Computing (Picard, 1997) is to create a machine able to understand the emotions of users and adapt its behaviour according to them. Two approaches to fulfill this goal has emerged: recognizing user emotions; and implementing the actual emotion procedures in machines. Emotion recognition, the main stream in the field, has a fairly long history of attempts to recognize emotions from facial expressions, voice and language. However, in research focused on recognizing the emotions, questions like "How to use the recognized information?" or "Is it enough to recognize the emotions, or is there something more?" are often neglected. Although the machine is meant to respond appropriately for user emotions, the actual research on how would those responses look like is rare or simplified (Tokuhisa et al., 2008). The new stream, focused on implementation of the emotions as agent-focused procedures, assumes that by providing the agent architectures for simulating emotional experience its reactions will be more human. This however leads to a more profound problem. The scientific description of human emotions is still incomplete and their implementation might lead to undesirable effects. An agent with implemented the procedure of "fear" activated in the case of failing to solve a task (Steunebrink et al., 2006), after approaching too many unmanageable tasks could become paranoid or depressive. Since paranoia is a typically human illness, such an agent would surely be human-like, but this kind of human-likeness should be considered rather as a defect, since there will be no practical usability of such an agent. Although architectures simulating emotional experience used as models for simulating human behaviour, might help understand emotional processes and contribute to curing psychosomatic diseases, such research should be performed with caution and attention of psychologists as much as computer scientists.

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[1]Neuron switching speed is known to be on the order of 10^{-3} seconds, whereas computer switching speed is of 10^{-10} seconds.

[2]Current estimates of brain capacity range from 1 to 1000 terabytes, whereas 64-bit computer architecture is estimated to be capable to process effectively 16.8 million terabytes.

Agent-companion for Emotion Management

In our research we focus on exploiting emotional information in user-agent interaction to enhance human lives. As the semantic and pragmatic diversity of emotions is said to be best conveyed in language (Solomon, 1993), we decided to focus on natural language processing methods for emotion recognition and their use in conversational agents, in particular the ones which perform a non-goal-oriented free conversation, or small talk. As is argued in the literature, small talk, although not goal-oriented, has important social functions (Coupland, 2003) and, e.g., in the form of humorous conversations, is a necessary mean of emotion management in counselling (Francis, 1994). It also has a great influence on children's acquisition of moral rules (Noddings, 1994). Therefore, in our assumption, in development of an agent-companion/counsellor emotional information conveyed during the small talk with the agent could be of good use. The human-likeness of such an agent is thus an important issue. We found out that by adding modality to the agent's responses makes them more natural (Higuchi et al., 2008). However, the naturalness is not the only issue. The agent-counsellor[3] should be able to recognize user's negative emotions and induce positive moods, e.g., by a humorous response. We showed that implementation of a joke generator in a conversational agent greatly improves its impres-

[3]We define the term 'counsellor' as 'a conversational partner able to help people understand and manage their emotions .'

sion (Dybala et al. 2009). However, a humorous response is not always the desirable, and, although mend to cheer-up the user with a joke, might cause the opposite effect, especially when she requires other responses, like a counsel or a consolation. Therefore the agent should be able to evaluate the user's emotions towards the context of the conversation to choose the appropriate response. Also, supported with morality rules (Rzepka and Araki, 2005), it should be able to detect the potentially inappropriate user utterances and react by pointing out the potentially undesirable consequences. To achieve this the agent must obtain a certain level of Emotional Intelligence.

Computing Emotional Intelligence

Emotional Intelligence (EI), as defined by Salovey and Mayer, is a kind of intelligence consisting of a set of 16-20 abilities grouped in 4 general groups labelled as: **I)** perceiving emotions; **II)** integrating emotions in facilitation of thoughts; **III)** understanding emotions; **IV)** regulating emotions. This set of abilities is assembled in an EI Framework. After close investigation of the framework, we found out that managing emotions was set as the final ability requiring the presence of all others. A surprising discovery was that recognizing emotions, on which Affective Computing has been focused for over 15 years was only the first, basic ability from the dozen or so, and the attempts to implement the EI Framework in machines eventually did not go beyond this step. The next ability in the framework is 'discriminating whether the expression of emotion is accurate for the situation it is expressed in'. In other words, whether it is appropriate or for its context. This introduces a new dimension in emotion recognition, since it assumes that both positive and negative emotions can be appropriate, or inappropriate, depending on their contexts (see the examples below).

1. I'm so happy I passed the exam! `[happiness/positive:appropriate]`
2. I'm so happy that bastard was hit by a car! `[happiness/positive:inappropriate]`
3. I'm so depressed since my girlfriend left me... `[depression/negative:appropriate]`
4. I'm so depressed for the Easter is coming... `[depression/negative:inappropriate]`

The structure of these particular examples consists of: expression of emotion (here: the beggining of the sentence), and its context (the latter part of the sentence). We developed a prototype method for verification of appropriateness of emotions in to contexts, which takes advantage of this type of sentences (Ptaszynski et al., 2009). In the method we first use affect analysis system ML-Ask to recognize users emotions. ML-Ask, based on a linguistic approach to emotions, first separates emotive utterances from the neutral ones basing on a set of emotive linguistic features. Then, it seeks for the specific expressions of emotion in the emotive utterances using an existing emotive lexicon. After specifying the emotion, a Web mining technique is used to verify their contextual appropriateness in 4 steps: **1)** extracting context phrases from an utterance; **2)** adding causality information to the phrases; **3)** cross-referencing the modified phrases on the Web with the emotive lexicon; and **4)** extracting lists of emotive associations for the context phrases. Emotions expressed by the user not appearing on the association list are perceived as inappropriate. The baseline method achieved an accuracy of 45%-50%. However, after improving ML-Ask wit Contextual Valence Shifters and limiting the searh in the Web minig techinique to blog contents, the accuracy was improved up to 60%-70%.

Conclusions and Future Work

We presented our approach to implementation of emotions in machines. We do not focus on pre-programming the emotion experience into the machine, but make our machine aware of emotion experience in the user. We consider the task as a step-by-step integration of abilities making up the Emotional Intelligence Framework. We showed that its possible to process emotions in their context, which corresponds to the ability to distinguish between appropriate and inappropriate emotions from this framework. The method paves the way to the implementation of other EI abilities, such as understanding emotions (for which we plan to reverse the procedure to obtain a database of formal objects of emotions), and regulating emotions (which will need a subset of conversational strategies for counselling). We believe that the implementation of the whole scope of EI Framework into machines is possible and will greatly contribute to the research on human-computer interaction.

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