Issues in emotion-oriented computing – towards a shared understanding

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Abstract. Emotion-oriented computing is a broad research area involving many disciplines. The network of excellence HUMAINE is currently making a co-ordinated effort to come to a shared understanding of the issues involved, and to propose exemplary research methods in the various areas. This overview paper presents a proposed "map" of the research area, distinguishing core technologies from application-oriented and psychologically oriented work. Current research issues in the various areas are briefly outlined, and references for further reading are given.

1 A map of research in emotion-oriented computing

Creating competent emotion-oriented systems is a large scale challenge. The European Network of Excellence HUMAINE (HUman-MAchine Interaction Network on Emotions) was established to prepare the scientific and technological ground for this task, with funding from the EU IST programme from 2004 to 2007. A first challenge was to agree on a suitable dissection into thematic areas and to determine their links [1]. Figure 1 summarizes our current understanding.

The central column represents the areas where purely technological challenges loom largest. Detection and synthesis are distinguished because the background technologies used are very different. 'Planning action' involves modelling action patterns that might be expected in a particular emotional state, either for driving an artificial agent or for anticipating a human's action tendencies in a given state.

The left hand column deals with issues where application is most obviously of concern. Emotion-related usability issues are more difficult to address than task-oriented ones, because emotional responses are subtle and easily disrupted by interventions that are meant to measure them. Iterative user-centered design methods are used for tuning a system to non-rational preferences and dispositions in the user. Work on emotion in complex media is treated separately because the perspective towards applications in the relatively near future requires a different approach than the core technologies in the central column.

The right hand column contains the sub-areas with the strongest roots in psychology. We distinguish theory and empirical data, because existing theory is informed by different kinds of data than what seems relevant for emotion-oriented computing. As a result, there are creative tensions between that kind of

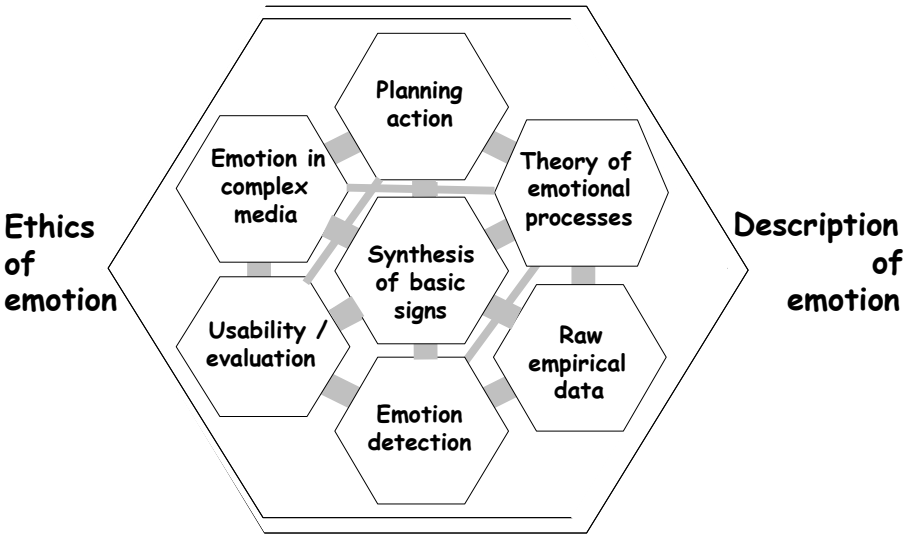

Fig. 1. Proposed map of the sub-areas involved in emotion-oriented computing

data collection and existing psychological theory. Similarly, psychological theory can use technology to test its accuracy and completeness, because the actions of artificial agents can be controlled with a precision that is impossible with humans.

The task of synthesising agents that can interact emotionally is at the center because it summarises the state of the art – it cannot be done well without satisfactory progress in all the others.

At either edge of the diagram are issues with a strong philosophical element which affect the whole enterprise – finding appropriate ways to describe emotions and emotion-related states, and the ethics of emotion-oriented systems.

2 Research issues and the state of progress

This section briefly touches upon the state of affairs in the various sub-areas as we address it. See the referenced work for more detailed presentations.

Description of emotion. Emotion-oriented computing needs tractable ways of describing the states that matter to it. Familiar schemes pull people to think in terms of pure fullblown emotion rather than pervasive emotion-related phenomena like friendliness, trust, distress, sincerity and mixed or time-varying emotions. Research in this area is clarifying the states most likely to matter to emotion-oriented computing, and adapting ideas from psychology such as soft coding, dimensional representation, and appraisal theory to provide representations that are more tractable than list of irreducible categories.

Theory of emotional processes. A joint understanding requires clear working definitions of jointly used terms. The term "emotion" has notoriously been used with very different meanings. Psychological theory has proposed working definitions of a range of affective states, including (fullblown) emotion, mood, attitude etc. These definitions are currently being refined in HUMAINE.

Different emotion models propose various analyses of emotional processes. Comparing such theoretical models with computational models provides new insights of what is actually required for an affectively competent agent.

Human behaviour is a natural reference for artificial systems, and as such it needs to be properly understood. It can provide a benchmark, but it is also important to understand individual and situational differences. One highly relevant aspect of this is research in the types of emotional and emotion-related states that are typically experienced by people in their daily lives [2].

Raw empirical data. Progress in most areas depends on good primary records, with appropriate annotation, of people interacting emotionally with each other and machines. There is a need for both generic material (to drive fundamental research) and application-specific (to achieve tuning to particular settings). Records also need to reflect differences between people related to their gender, culture, and individual characteristics, and the context in which they are set. Techniques for both collection and annotation have been developing, and are currently being exemplified in the collection of a pilot database [3].

Detecting emotion. Research has explored many of the channels that people use to form impressions of each other's emotions – facial expression, paralinguistic, gesture, choice of words and actions. Physiological correlates of affect also exert a special fascination. High recognition rates can be obtained with acted or carefully elicited data, but the field has moved on to deal with naturalistic material. There it is difficult to exceed 80% success in a binary distinction. Multimodal integration seems the likeliest key to real improvement [4].

Expressive behaviour. As in perception, the existence of multiple channels is critical. Early 'Embodied Conversational Agents' (ECAs) tried to convey emotion using analyses of static faces showing fullblown emotions. The results are recognisable, but disconcerting. Research has moved on to study the rich range of signals that transmit emotion-related information in interactions, and the ways they are co-ordinated and dependent on the other party's actions. That raises topics such as eye movements, backchannelling, gesture, and 'idle movements'. Co-ordinating such behaviour is a precondition for believable interactions [5].

Emotional cognition. An agent cannot engage emotionally unless it has a kind of empathy, i.e. it can understand at some level what a person's emotional state might dispose him or her to do, and how that disposition might be affected by different actions that the agent might take. Hence interfaces need to include models of central states and processes in the user that incorporate emotion. At present, several very different types of model are available – AI (using propositional representations); neurally inspired; and artificial life. Each has strengths, but it is difficult to combine them, and finding ways to do that stands out as the immediate priority [6].

Emotion in complex media. Emotion can be expressed and influenced not only through basic channels established by evolution, but also through music, colour, typography, and above all language. Within language there are many ways to express and influence emotion, including choice of argument, lexical selection, politeness, and humour. Work is in progress integrating all of these into the theory and practice of emotional communication [7].

Guiding system development. Translating theory into product poses special problems in the area, not least because emotional aspects of response are singularly difficult to measure without changing the experience. Innovative usability tests and user-centered design methods are needed to gauge the kinds of innovation people may want and the way they respond to prototypes, to deliver appropriate information to designers, investors, and users, and so on. Viable products depend on combining these streams with traditional research [8].

Ethics. Influencing people's emotions raises ethical questions, but over-reaction to the issue could stifle thoroughly desrirable developments. The field urgently needs an ethical framework that distinguishes between benign and suspect kinds of development, allied to appropriate monitoring systems. In HUMAINE, a framework based on Principlism has been proposed. It is important to consolidate that kind of framework and ensure that it is generally accepted [9].

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