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Emotions in Hybrid Social Aggregates

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Abstract

Research on emotion has just started to investigate emotions on higher levels of social interaction and aggregation, e.g. organizations or distributed work environments. For a long time the focus has been on the interrelation of cognition and emotion in individuals. But as more and more research is conducted on emotional effects in social interaction, aggregation, and emergence, it becomes obvious that the results are also important for emotional agents (both, natural and artificial) in human-computer interaction. Until now, computer scientific studies – mainly inspired by cognitive science – have designed sophisticated emotional architectures for dyadic interactions. But as emotional agents are increasingly required to engage in social interactions within larger aggregates, either as embodied systems or via multimodal interfaces, the need arises to precisely consider the social-structural peculiarities of emotion. Unfortunately, within the social sciences there is no integrative theory of emotion that interrelates various cognitive and sociological aspects and that computer scientists could use to design improved emotional agents and emotion supporting systems. Therefore, we propose a way to integrate sociological and cognitive theories to analyze emotions on three levels of abstraction: cognitive, interactional, and social structural. We illustrate various reciprocal causes and effects of emotion on the different levels and relate them to urging questions in emotional agents design and human-computer interaction.

1 Introduction

It is now widely accepted that emotions and corresponding mechanisms could play a major role in the design and construction of software agents. Expected advantages are manifold: Emotion as a prerequisite of (artificial) intelligence, the well-known interrelation between cognition and emotion, and emotion expressions as a crucial part of human-like respectively believable behavior. Still, the focus of attention in developing emotional agents for all kinds of purposes and applications is on cognitive theories of emotion. Following a bottom-up approach to modeling, it seems reasonable to start constructing agents with one individual agent in mind, to equip singular entities with capacities to "simulate" emotional behavior or to develop different kinds of emotional heuristics for improved decision-making, plan generation or action selection.

But in conjunction with the turn artificial intelligence (AI) took towards distributed artificial intelligence (DAI), new questions and requirements for emotional agents design arise. As emotional architectures of isolated agent-entities become more and more sophisticated (see Trappl/Petta (2001) for an overview), the challenges widen from dealing with emotions in a single agent-entity toward investigating emotional phenomena in multi-agent systems, hybrid systems or distributed agencies.

At the same time, there is a continuous trend toward distributed organizational structures ("virtual organization") that require remote units or individual employees to interact and cooperate over long distances by means of computer mediated communication (CMC). Research conducted in the field of telework has revealed several disadvantages experienced by employees as well as by executives. Problems encountered are not only technical but often social in nature, such as lack of commitment, isolation, leadership, control, involvement, etc. (Reichwald/Bastian 1998; Büssing 1996).

According to Büssing (1996) and Mania/Chalmers (1998), some of these social problems can be traced back to the absence of face-to-face interaction, also in collaborative virtual environments (CVE). Furthermore there are other factors responsible for specific social inefficiencies, e.g. problems arising from trust deficiencies (Jones/Marsh 1997). Altogether, it seems reasonable to design systems for distributed work environments in a way that allows to cover at least some aspects of emotion expressions. Therefore, we illustrate an integrated approach that accounts for cognitive as well as social dynamics of emotion. Combining these two perspectives may lead to a theory of emotion that is suited to design improved emotional agents for human-computer interaction, account for emotional needs in computer supported cooperative work (CSCW) and give us a more sophisticated understanding of emotional processes in (natural and artificial) social aggregates, e.g. groups, teams or organizations.

It is supposed that this shift in perspective demands an increased consideration of problems concerning the *social interaction* of artificial and human agents, not only in dyadic but also in multilateral interactions. Prominent fields of interest are e.g. coordination, cohesion, cooperation, conflict (resolution), negotiation, norms, teams, organizations, group dynamics or artificial societies.

In view of these issues the role of emotion has not been examined thoroughly, especially from a sociological point of view. This paper deals with two main questions: Why have these issues been neglected at large so far, and how could a detailed investigation of the social components of emotion provide new directions and perspectives for (1) human-computer interaction, (2) emotional agents design and (3) interdisciplinary theoretical emotion research in general.

We start with a survey of concepts that seek to integrate emotions in the process of human-computer interaction. We will then illustrate in which way the mentioned approaches have not yet focused on the specific problems arising from (generic) distributed and large-scale environments consisting of more than two agents. It is shown that the combination of social science and cognitive science models of emotion seems promising in view of the problems addressed.

The following section then depicts in more detail how an integrative emotion-theoretical approach could be realized. Three different levels of analysis are presented and we briefly address the problem of modeling the theoretical concept.

2 Human-Computer Interaction and Emotion

The emerging field of "affective computing" is defined by Picard as "computing that relates to, arises from or deliberately influences emotions" (Picard 1997). In broad terms, this field can be subdivided into efforts to (1) capture and model emotional user states, (2) to synthesize emotions in computer systems for optimized reasoning or decision-making capabilities or (3) to build emotionally expressive systems for richer interactions. Many of the up-to-date approaches prefer

agent oriented systems design, especially in the field of human-computer interaction (HCI) (Beale/Wood 1994).

Research conducted on the various aspects of affective computing is focused on cognitive and recently also on social components of emotion. The social dimension is analyzed mainly in view of dyadic agent-human or agent-agent interactions (Canamero 2001). These interactions are considered to be social since they happen between two more the less intentional entities (and not between an intentional entity and an inanimate object) and are characterized by reciprocity and contingency.

What has obviously been neglected so far is the fact, that social worlds are more than a collection of social agents inhabiting this world. Social systems have qualities ("social facts") that emerge from interactions taking place within this system – but these qualities and their causes often cannot be traced back to an individual agent. Nevertheless, they are a major source of influence on any agent's cognitive system, its interactions, and emotions.

It has been shown that "affective interactions" are desirable for some kinds of applications and should be grounded on "how *people* interact with each other" (Paiva 2000: 1; emphasis added). This is not just valid for single-user workspaces but also for distributed CSCW or CVEs (Zhang et al. 2000). Another important aspect that supports our hypothesis is that CMC in virtual environments has the potential to generate and/or transform social structures and corresponding "social facts", e.g. conventions (Becker/Mark 2000).

Summarized, when emotions shall be incorporated into CVEs or when the effects of (ad-hoc) implementations shall be thoroughly analyzed, the question arises how the emerging social structure of the environment is interrelated with agents' (natural or artificial) emotions.

The combination of cognitive science models of emotion and sociological theory can help to answer these questions since sociology is concerned with the definition of specific social settings and situations, and with the description and examination of relationships actors maintain with each other.

3 Different Levels of Emotion Analysis

In general, emotion can be looked upon from two perspectives: emotion as an independent variable or a dependent variable. On the one hand we need to acquire knowledge about the conditions of the physical and the social world that lead to the elicitation of specific emotional states and processes. On the other hand it is of interest how specific emotions (once elicited) may alter the social and the physical world (by expression or somatic symptoms) and how they affect cognitive processes of primary and secondary appraisal (Scherer 1993).

The first question is strongly dependent on the domain an agent is situated in. What kind of information may be sensed by an agent/actor, is this information subject to interpretation and subjective construction or is it solely factual (objective) knowledge about the "physical" environment? Using appraisal theory then, emotional states may arise from perceiving environmental qualities and events and mapping them with internal belief systems, needs, goals, preferences, etc. (Ortony et al. 1988).

The second question concerns the way emotions themselves affect agents' cognitive and bodily capacities. In which way do emotional states modify the ability to perceive and appraise

information from the external world, to infer, to make decisions, to select actions or to make plans? In this respect, emotions even play a crucial role in the elicitation of other (forthcoming) emotions. In short, the question is: how do emotions interfere with the processes subsumed under the first question? There is a large body of literature dealing with this specific question, the works of Damasio or Le Doux being the most recognized within the agents community (Damasio 1994; Le Doux 1996).

Apparently, these two questions make up a reciprocal functional loop within the emotion process, and it seems obvious that leaving out one of these two components in agents-design will lead to an insufficient contemplation.

The two issues treated until now focus the effects of cognition on emotion and vice versa. What has been neglected so far is that interacting agents are *socially embedded* agents, that means they are not only situated within a physical environment but additionally in a social world. Some peculiarities of the social world which may have an influence on the emotion process are: social-structural implications; organizational structures and hierarchies; institutionalizations (norms, rules, standards, contracts); interaction histories; socializations; roles and habits; commitment; subjective meanings; etc.

Thus, the main problems that arise when we have to deal with socially embedded agents are contingency, reciprocity, and interdependency. We will show in which ways these qualities determine the emotion process on different levels of abstraction. To do this, we set up a three-level scheme consisting of micro-, meso-, and macro-level analysis that enables us to describe and interlink (1) social impacts on causal determinants of emotional state (micro-level), (2) effects of emotion on the causal "elicitation-chain" (micro-level), (3) properties of interaction situations (meso-level), and (4) social structures and emergent phenomena ("social facts") (macro-level).

Until now, existing approaches to emotion from different schools of thought focus on aspects of emotion that are most relevant for their own discipline (e.g. Scherer/Ekman 1994). It is often neglected that all these aspects are highly reciprocal in nature. Analyzing only selected properties may be sufficient for some aims of the social sciences but when the goal is to create technical artifacts capable of producing and utilizing the power of (artificial) emotions, it becomes necessary to focus also on the *link between* the different aspects.

Combining social science and computer scientific research on this issue seems quite promising, since computer science can provide technical means to handle the issue's inherent complexity (agent technology, simulation) and the social sciences can provide a large body of theoretical and empirical research. Cooperation between the distinct disciplines will lead to a better understanding of the natural phenomena and to improved technical models and architectures. This is especially the case when theoretical work relies on computer scientific paradigms and requirements for the formulation of theory (precision, terseness) – advantages will be adaptability, simplified operationalization, and means for validation.

3.1 Micro-Level Analysis

What is subsumed under the term "micro level" here has definitely attracted most of the attention of emotion researchers from various disciplines. Central to this topic is the interrelation between emotion and cognition. Extensive research has been conducted to this area of study, either examining the effects of cognition on the elicitation of emotional states or the effects of emotion on cognitive processes. Related to these questions are investigations on how emotions influence

action and behavior. Recent publications draw heavily on results from the neurosciences, stating that intelligence as a whole is strongly dependent on emotion.

One of the most prominent theories of emotion is the one by Ortony and associates that focuses the cognitive structure of emotion (Ortony et al. 1988). The "OCC" Model of emotion has inspired the design of several emotional agent architectures, e.g. the "Affective Reasoner" or the "OZ"-Agents (Elliot/Brzezinski 1998).

What is left out by most of the current micro level analyses is the fact that those properties of an agent which are responsible for emotion generation may alter to varying degrees and according to specific circumstances. It has been shown that not only relatively high-level mental concepts like cognitive-maps, schema-maps or belief-systems are subject to variation and modification, but also more "basic" cognitive capabilities like perception, inferring, memory formation, planning, motivation or attention. As explained in Moldt/v. Scheve (2001), schema-maps for example, which are constitutive for the emotion antecedent appraisal process, are internalized to different degrees. That means some of these functional mappings are held up by individuals for a lifetime (preferably those acquired during early childhood socialization) and others are acquired only temporarily according to specific requirements and social settings.

Like schema-maps, other cognitive capabilities and representations may develop and/or alter according to the social setting socialization takes place in. Social structural configurations such as social classes, groups, milieus, stratums, etc. impose regularities on the development and the shaping of characteristic cognitive features (Turner 1999). Studies on social cognition and socially shared cognition depict in detail the fundamental interactions between individual and society down to those levels that have long been assumed to be exclusively "individual" in nature (Augoustinos/Walker 1995).

In view of the emotion process it is important to emphasize that cognitive determinants of emotional state are not purely "hard-wired" mechanisms; they rather depend on the different social settings an actor/agent is or has been situated in. In view of emotional agents design this issue relates to the question which aspects of emotional behavior should be treated during design-time or during run-time. We will deal with this question in more detail in the following sections.

3.2 Meso-Level Analysis

Analyzing the meso-level of the emotion process moves away from examining internal agent characteristics toward the analysis of more abstract features that play an important role in social interactions. Issues to be addressed are: What are the characteristics of social interaction situations and how do they affect the emotion process; in which way are these characteristics influenced by emotional states respectively emotion expressions of participating actors; how are emotion expressions themselves perceived as significant characteristics of an interaction situation?

These questions suggest a more sociologically oriented analysis since, "[...] it is precisely the sociologist who is most concerned with the definition, conceptualization, and elaboration of the categories of the social environment: social class, bureaucracy, normative order, division of labor, hierarchy, power, status, and the like" (Kemper 1984: 370). Therefore, it is necessary to use suitable methodologies that lead to consistent definitions and conceptualizations of the properties of the social world. Using selected basic concepts of interaction analysis – frames, roles, norms, rules, and attributions – several specificities can be highlighted that may become a part of emotion generation and emotion expression.

Social norms for example lead to what Flam has called the "constrained emotional man" (Flam 2000). In social interactions, emotions are rarely felt and expressed the way they are originally experienced. They are subject to modification and regulation in order to fit prevailing norms and rules which are perceived to be valid in an interaction. This phenomenon is extensively covered by the concepts of "feeling rules" and "emotion work" (Hochschild 1983). Furthermore, the importance of social norms and rules with respect to verbal and nonverbal communication has been emphasized (Fiehler 1990).

Comparable to emotion regulation (according to social norms) is the intentional and strategic use of emotion expressions. The intentional elicitation of specific emotions and corresponding expressions is of utmost importance in negotiations, the formation of coalitions or evolving cooperation among agents. Evidence suggests that the "rational" utilization of emotions in a way that meets expectations of interaction partners can lead to significant advantages in situations of social exchange (Lawler/Thye 1999). This is also shown by Frank, providing a game-theoretic model of the strategic use of emotion (Frank 1988).

Another important aspect in social interactions is the position of the participating agents in the social world. These positions can be described by certain forms of social capital, e.g. status or power. Status and power are resources constantly exchanged in interactions. When the loss or gain of a resource surpasses a certain threshold level and is furthermore interpreted as being inadequate, specific emotions may arise. Interpretations of adequateness strongly depend on the overall distribution of these resources within a social aggregate (Kemper 1978/1984; Kemper/Collins 1990).

Another question to be addressed on the meso-level of analysis is the problem of relevance, which is closely related to the AI problem of symbol-grounding. Because *some* emotions are one of the few meaningful understanding- and communication-systems which are *not* socially or culturally grounded as a whole, the problem arises in how far interferences occur between socially/culturally embedded meaning on the one hand and biologically determined codes of meaning on the other hand.

To get a more complete picture of the emotions and to design improved emotional agents the properties of interaction situations have to be considered. Based on the sociological concept of interaction frame-analysis models of situations and actors could be created and related to emotion elicitation and expression (see also Moldt/v. Scheve (2001a/2002)).

3.3 Macro-Level Analysis

Having outlined the way social settings influence the emotions on the cognitive and dyadic interactional level, we will now focus on larger aggregates of individuals and social structural effects on/of emotion. As stated earlier, relatively stable social settings such as classes, groups or milieus impose regularities on the cognitive structures of individuals belonging to one or more of those aggregates. Also, belonging to a specific form of social aggregate may be of importance for frame analysis on the meso-level. Micro- and meso-level analyses dealt with emotion as a dependent variable whereas the macro-level analysis is a change in direction towards treating emotion as an independent variable.

It has been shown that emotions play a vital role in the evolution and development of social structures and in processes observable in social aggregates such as inclusion, commitment or cohesion. Investigations have shown that persistent "emotional climates" or "moods" within

(informal) groups, communities or social networks can have strong effects on the stability and dynamics of a social structure. Emotions are often highly "infectious" in character, so that the emotions of key-individuals may rapidly spread within a social aggregate. Also, steadily and regularly reproduced emotions as results of specific interaction-ritual chains may have strong effects on solidarity, cohesion, and inclusion (Klein/Nullmeier 2000).

Especially in organizations with heterogeneous member-structures a practice has been observed that is called "emotion management". This strategy is carried out by some key-individuals and aims at establishing a widely shared "positive emotional climate" that is considered to be advantageous for an organization. Emotion management relies on every single individual's capability to perform what has earlier been labeled "emotion work" (Flam 2000). Emotion management is the attempt to artificially generate and control "positive" group-emotions that occur spontaneously mainly in informal groups or communities (Fineman 1993). Scherer has labeled this kind of capability "collective emotional intelligence" (Scherer 1999).

These approaches generally presuppose the existence of some sort of social structure, without picking out the emergence of these structures as a central theme. This is done by Collins who states that regular exchange of some sort of "emotional energy" constitutes a basic motivation for social interaction (Collins 1984). According to his approach, frequently reproduced interactions and corresponding emotional outcomes on the micro level will lead to the formation of relatively stable structures on the macro level.

Another important functional dimension of emotions is their relevance for the emergence and maintenance of social norms and rules which are constitutive for any form of sociality. Deviant individuals are normally sanctioned by "negative" emotions such as shame, embarrassment or guilt, whereas those confronted with deviant behavior feel anger, rage, pity or similar emotions (Elster 1996).

In summary, it can be said that in environments inhibited by large numbers of individuals it is necessary to consider the effects of structural and emergent phenomena on the emotion process. Structures do not only impose regularities on every individual's cognitive features for appraisal and emotion elicitation, they are also partly made up by constantly repeated emotional outcomes of interactions. Also, the structural stability of social aggregates depends on specific emotions that support commitment, cohesion and inclusion.

4 Discussion and Outlook

We have presented and illustrated a first conceptualization of a three-level analysis of the interplay between emotion and instances of social aggregates. The interrelations depicted are of importance in different respects: They are needed to design computer supported cooperative work respectively cooperative virtual environments which are supposed to take into account emotional aspects of agent interaction, whereas in our approach an agent is considered either a human user or an artificial interface agent. Furthermore, our way of emotion analysis is also suitable for the design of user representatives in virtual environments ("avatars") or the design of socially embedded agents in multi-agent systems.

The way emotions are conceptualized here can be related to all areas of affective computing research described earlier and may be used to extend existing approaches from the field of

cognitive science and (social) psychology. Especially emotion-expression and emotion-synthesis mechanisms in artificial agents may be extended in view of social structural influences.

On the other hand, we do not only intend to improve computational systems design but also to make a valuable contribution to theoretical social science emotion research. Our approach to modeling the results of emotion-theoretic (and empiric) investigation by means of Petri nets addresses some major methodological problems within the social sciences. Turner has illustrated the importance of models for the advancement of social science research: “Such models [...] can provide a picture of process – that is, of how variables influence each other across time. Moreover, they can also give us a view of complex causal processes. Too often in sociology, we employ simple causal models [...] that document one-way causal chains among empirical indicators of independent, intervening, and dependent variables. But actual social processes are much more complex, involving feedback loops, reciprocal causal effects, lag effects, threshold effects, and the like” (Turner 1988: 17). One further important intention of our approach is to provide means that allow a sociologically (or even socially) founded analysis of new systems that will be deployed intentionally and unintentionally in the near future. The concept of emotion has to be understood to avoid undesired or forbidden kinds of influence on humans involved in virtual and/or real environments.

Petri nets are an ideal means to generate abstract models, especially with respect to concurrency, reciprocity, and recursiveness. They can be used to model actions and states and to reveal system deadlocks and other system concepts or properties in a way that is also comprehensible for social scientists. An extended kind of Petri nets enable social scientists to express theoretical findings with operational semantics and not in written or oral natural language. That means, when formulating complex theories, one is enforced to be extremely precise and terse. There is not much room for different interpretations of the meaning of a theory – an occurrence that tends to be a problem in the social sciences, especially in sociology.

To model the integrative emotion theory, we will draw on results from a previous project within which Petri net based multi-agent systems are designed to model organizational decision-making. Specifications are made according to an agent oriented, high-level Petri net formalism that allows implementation of most fundamental agent and multi-agent system concepts in an intuitive, precise, graphical, and directly executable way (Köhler et al. 2001).

We have implemented first prototypes for generic multi-agent systems. The architectures concentrate on traditional artificial intelligence and software engineering concepts up to now and it is planned to extend the architecture for our integrative concept of emotion.

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