Book Review

Affective Computing and Interaction:
Psychological, Cognitive and Neuroscientific Perspectives

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Affective Computing and Interaction: Psychological, Cognitive and Neuroscientific Perspectives
Didem Gökçay and Gülsen Yildirim (Eds.).
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Fifteen years have passed since Rosalind Picard's seminal first book on Affective Computing appeared (Picard, 1997; Lisetti 1998). Although in the 1990s the few visionaries interested in making connections between affective phenomena and computing were originally laughing matter in the research community (Picard, 2010), they have succeeded in establishing what is now recognized as a dynamic interdisciplinary field of research. Affective Computing is now represented by one dedicated international conference (Tao, Picard, & Tan, 2005), two international journals (Gratch, 2010; Vallverdú, 2010), and many top rated conferences and journals regularly dedicate sessions and special issues to a variety of affective computing topics.

In this excellent book, Didem Gökçay and Gülsen Yildirim have compiled an interdisciplinary collection of chapters, from authors of diverse scientific background, which thoroughly covers the topics in affective computing that focus on interaction (between humans, animals, or computational agents). Gökçay and Yildirim point out the many challenges that exist before we can build affective computers that can recognize and express emotions for more natural, effective, entertaining and healthy human-computer interactions. They make the welcomed argument that there is a need to move beyond the current trends in the field, which have focused on recognition of the user's psychological affective state with machine learning of psychophysiological measures of user's emotional signals (e.g., skin conductance,

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heart rate) according to some pre-determined categories of emotion (anger, happiness).

To that end, the book educates its reader on fundamental knowledge necessary in order to understand the current state of the art, as well as in order to advance it by moving toward computational models of internal affective representations that can account for the "time-varying continuum of emotions" (similar to human emotions). The book is well organized in five sections: Section 1 on *foundations* of affect from neuroscience, bio-psychology, and psychology perspectives; Section 2 on theoretical and computational *models* of emotions; Section 3 on *non-verbal* communication of affect; Section 4 on aspects of *verbal* communication of affect; Section 5 on existing *applications* of affective computing in human-computer interaction; and an Epilogue on *philosophical* implications of creating affective machines. Rather than discussing every chapter in each section, I will highlight a few of the discussions and provide my perspective as to which open research questions in affective computing interactions they most contribute to.

In the foundation Section, Erdem and Karaismailoğlu provide a detailed discussion of the neuroanatomical and neurochemical substrates linked with the sensation, expression, and subjective experience of emotions. Specific references are also provided about the neural underpinning of processes of empathy found in 'mirror neurons'. Because empathy has recently emerged as a particularly interesting topic to model supportive virtual agent capable of establishing rapport and helping users in socio-emotional contexts, these references should prove interesting to researchers modeling empathy. In his chapter, Smith highlights the bio-psychology of affect and of implicit (unconscious) and explicit (conscious) motivation. He proposes a "dual process account of human behavior that integrates motivation, emotion, and cognition." An appendix makes further connections between the mammalian 'incentive motivation network' and the brain mechanisms that underlie it. Although of real importance, the unconscious aspect of emotion has only started to be studied in affective computing research (Hudlicka, 2009), and Smith's bio-psychological theory provides very interesting insights into modeling unconscious emotional processes. The foundation section also includes an absolutely necessary chapter by Gökçay on the various theoretical emotional axes discussed in the psychological literature to differentiate emotions along *n* dimensions. It focuses on the 2-dimensional (2D) approach which classifies emotions along the two valence and arousal dimensions, and describes in details two different 2D models: Circumplex (Russell, 1980) and PANA (Watson, 1999). It addresses some of the controversies regarding these 2D approaches, including their relation to Ekman's categorical theory on the existence of six (or seven) basic emotions (Ekman, 1994). Gökçay also provides a neural network model of iterative evaluation processes of emotions that supports the Circumplex and PANA. Although not explicitly mentioned in this section, an interesting account about these controversies can also be found in Russell and Feldman Barrett's article (1999), in which they ascertain that the term emotion is too broad to be a single category. They introduce two useful distinctions to address some of the dimension vs. category controversies: a) core affect as non-directed, always present, most elementary affective feeling, structured by two bi-polar dimensions, and b) prototypical emotional episode as (what is usually referred as emotion), a short-lived complex set of interrelated sub-events directed toward some object, and structured by categories. Gökçay's chapter on the structure of affect and emotions is therefore extremely important to affective computing on interaction because it raises issues that are at the core of design decisions for both the computational simulation of emotional generation processes (i.e., what type of affective phenomena does an affective agent simulate?), and targeted results of emotion recognition algorithms (i.e., should the algorithm discriminate the user's expressions of affect on a discrete or continuous space?)

In the Section on emotional models and frameworks, Scheutz presents an evolutionary

model of affective control that support the survival of biologically plausible affective agents with foraging and conflict resolution tasks in a multi-agent competitive environment. Using the method of synthetic ethology that makes claims about the likely evolution of agents by performing simulation experiments, the author discusses results about how transmission of single signals leads to better performance in social coordination among simple agents rather than complex forms of symbolic schemata-based communication. Without excluding the possibility of more complex control systems evolving to meet the needs of agents situated in highly structured environment or with limiting sensory apparatus, Scheutz further proposes that simple affective control states are very likely to evolve and might be the cause for why evolution created so many simple creatures with only simple signaling communication. The discussion about the evolution of biologically–plausible simple agents is an important one as it addresses issues about how to design increasingly efficient affective agents, without imposing a top-down symbolic-based agent architecture that might unnecessarily slow down the agent performance. Korsten and Taylor chose to discuss a model of emotional appraisal using four different value assessments (current, expected, predicted, and standard). Another emotional framework discussed by Castelfranchi studies a different problem: he argues that, in addition to the detection and recognition of expressive multimodal signals associated emotions, a theory of mind is necessary if a computer system is to understand the user's emotional states during human-computer interaction. His approach aims at addressing some of the limitations of current computational approaches to emotional recognition (i.e., only considering the expressive *signals* emitted by the user during an emotion experience) by introducing the concept of "cognitive anatomies" of emotions, which refers to the user's interpretation of the eliciting stimulus (the meaning given to the event). To make his point about the necessity of mental configurations, Castelfranchi focuses on modeling some anticipation-based emotions (hope, fear, disappointment, relief, joy) and some social emotions (shame, envy, guilt, pity). These emotions typically involve the process of expectations, which in turns involves mental concepts such as the belief that an event will occur, the goal to know whether the event will indeed happen as anticipated. Cognitive anatomies for these anticipated emotions are decomposed explicitly in terms of goals and beliefs, and in terms of quantitative independent parameters (goals have a value to the subject in terms of importance, and beliefs have strength in terms of degree of certainty). But Castelfranchi does not stop here, he further argues for the need for connecting these cognitive anatomies with the notion of somatic subjective experience of emotions. He proposes an explicit symbolic model that attempts to address the ongoing chasm between researchers analyzing affective bodily signals – alone, and those modeling the cognitive aspect of emotions – alone.

The Section on nonverbal communication includes three chapters which provide extensive surveys of the state of the art and future directions on automatic interpretation and synthesis of expressions of emotions. Vinciarelli and Mohammadi's chapter surveys the "technology of nonverbal communication", with an account for the main trends in the psychology of nonverbal communication (e.g., gestures, postures, facial expressions, gaze and vocal behavior), and of the state of the art in technology of nonverbal communication from an automatic recognition perspective using signal processing - with a special focus on vocal behavior. Ali Salah, Sebe, and Gevers' chapter on automatic interpretation of affect from facial expressions revisits the issues introduced in the foundation Section about choosing an appropriate scheme to classify facial expressions of emotions automatically. They provide a useful starter's kit for computer analysis of facial expressions, going over the main computational modules necessary for the tasks, while listing a set of resources available for researchers interested to work on the topic (databases, software tools), as well as suggestions for application of facial expression recognition. A discussion on non-

verbal communication would not be complete without mentioning latest progress on facial expression synthesis which is provided by Buciu, Nafornita, and Gordan, who present the latest trends in character and avatar animation.

As mentioned by Gökçay and Yildirim, verbal communication has still not been covered extensively in affective computing and interactions. So in the Section on affect in language-based communication, an account of the social-emotional framework of language development given by Hohenberger might offer an incentive to start modeling affective language acquisition in a similar incremental manner that Breazeal (2003) started to model infant social intelligence on an affectively expressive robot. Another mention of the 'mirror neuron' system is offered in the appendix, which once again points to interesting findings for researchers interested in modeling empathy. Additional chapters on text-based communication address different topics. The role of intimacy and gender on emotions in mobile phone email in Japan is investigated by Kato, Scott, and Kato. On a different topic, Yildirim and Gökçay draw some fascinating parallels between a set of frequently observed behavioral problems with Computer-Mediated Communication (CMC) and problems experienced by patients with brain lesions. This chapter provides a very novel look at text-based communication and its limiting lack of affective features in CMC, as well as some interesting suggestions for requiring changes in text-based CMC applications. This type of approach could also prove inspiring to study implications of the use of a number of other technology applications and their possible improvements with affective interactions.

The last Section on emotions in human-computer interaction (HCI) gathers various chapters describing applications of affective computing. A literature review of the affective aspects of HCI is provided by Akgüm, Kaplan Akilli, and Çailtay. An account of how affective technology can be designed to assist children with autism spectrum disorders is provided by Welch and her co-authors. The growing importance of computers for our entertainment is emphasized by Sykes who gives an overview of how video-games can elicit emotional experiences as rich as those provided by other entertainment media (film and television). El Nasr, Morie, and Drachen, on the other hand, discuss in details design techniques developed by artists to create interactive entertainment that engage the user at a very deep emotional level. They also describe a scientific approach to validate the use of these design techniques (e.g., color and lighting techniques) in eliciting emotions (currently arousal) via a series of experiments measuring the user's physiological signals (e.g., galvanic skin response, temperature) in terms of arousal. One particularly interesting concept introduced in this chapter is the one of "emotional affordance" which parallels Gibson's perceptual affordances (1979): "if a perceptual affordance is a perceptual cue to the function of an object that causes an action, then an emotional affordance is a sensory cue to the function of a stimulus that causes an emotional reaction" (El Nasr et al., 2011) (p. 282). The study of emotional affordances has many implications in affective computing and interactions, and a similar approach to El Nasr and her co-authors could be used in many applications of affective computing (e.g., health intervention applications, intelligent tutoring systems).

In conclusion, I found that the book as a whole provides an excellent coverage of the main topics on affective computing and interaction, with nice links between the foundation section and the subsequent sections that expand on the issues introduced early on. Readers from different background will be able to understand the material written from an interdisciplinary perspective, acquire a strong background on the foundations and on the state of art in affective computing, and, hopefully join the fun of brainstorming in years to come on the suggested ideas for future research on affective computing and interaction.

REFERENCES

Breazeal, C. (2003). Emotion and sociable humanoid robots. *International Journal of Human-Computer Studies*, *59*, 119–155. doi:10.1016/S1071-5819(03)00018-1

Ekman, P. (1994). All emotions are basic. In P. Ekman & R. J. Davidson (Eds.), *The nature of emotions: Fundamental questions* (7-19). New York, NY: Oxford University Press.

Gibson, J. J. (1979). *The ecological approach to visual perception*. New York, NY: Houghton Mifflin.

Gratch, J. (2010). Editorial. *IEEE Transactions on Affective Computing*, *3*(1), 1–10. doi:10.1109/T-AFFC.2010.11

Hudlicka, E. (2009). Book review: Emotion and consciousness. *International Journal of Machine Consciousness*, *1*(2), 281–297. doi:10.1142/S1793843009000372

Lisetti, C. L. (1998). Invited book review of Affective Computing by R. Picard from MIT Press. *Pattern Analysis & Applications*, *1*, 71–73. doi:10.1007/BF01238028

Picard, R. (1997). *Affective computing*. Cambridge, MA: MIT Press.

Picard, R. (2010). Affective computing: From laughter to IEEE. *IEEE Transactions on Affective Computing*, *1*(1), 11–17. doi:10.1109/T-AFFC.2010.10

Russell, J. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1178. doi:10.1037/h0077714

Russell, J., & Fedman, B. L. (1999). Core affect, prototypical emotional episodes, and other things called emotion: Dissecting the elephant. *Journal of Personality and Social Psychology*, *76*(5), 805–819. doi:10.1037/0022-3514.76.5.805

Tao, J., Picard, R., & Tan, T. (Eds.). (2005). *Affective computing and intelligent interaction: First International Conference* (LNCS 4738). Berlin, Germany: Springer-Verlag.

Vallverdú, J. (2010). Editorial preface. *International Journal of Synthetic Emotions*, *1*(1), 1.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology*, *76*(5), 820–838. doi:10.1037/0022-3514.76.5.820