Chapter 13
Computational Analytical Framework for Affective Modeling:
Towards Guidelines for Designing Computational Models of Emotions

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ABSTRACT

Computational affective models are being developed both to elucidate affective mechanisms, and to enhance believability of synthetic agents and robots. Yet in spite of the rapid growth of computational affective modeling, no systematic guidelines exist for model design and analysis. Lack of systematic guidelines contributes to ad hoc design practices, hinders model sharing and re-use, and makes systematic comparison of existing models and theories challenging. Lack of a common computational terminology also hinders cross-disciplinary communication that is essential to advance our understanding of emotions. In this chapter the author proposes a computational analytical framework to provide a basis for systematizing affective model design by: (1) viewing emotion models in terms of two core types: emotion generation and emotion effects, and (2) identifying the generic computational tasks necessary to implement these processes. The chapter then discusses how these computational 'building blocks' can support the development of design guidelines, and a systematic analysis of distinct emotion theories and alternative means of their implementation.

1.0 INTRODUCTION AND OBJECTIVES

The past 15 years have witnessed a rapid growth in computational models of emotion and affective agent architectures. Researchers in cognitive science, AI, HCI, robotics and gaming are developing 'models of emotion', primarily to create more believable and effective synthetic characters and robots, and to enhance human-computer interaction. Less frequently, these models are being developed for

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basic research purposes, to help elucidate the nature of the mechanisms mediating affective a variety of affective phenomena.

Yet in spite of the many stand-alone emotion models, and the numerous affective agent and robot architectures developed to date, there is a lack of consistency, and lack of clarity, regarding what exactly it means to 'model emotions' (Hudlicka, 2008b). The term 'emotion modeling' in the affective computing literature can refer to a wide variety of processes and models, including: the dynamic generation of emotion via black-box models that map specific stimuli onto associated emotions; generating facial expressions, gestures, or movements depicting specific emotions in synthetic agents or robots; modeling the effects of emotions on decision-making and behavior selection; including information about the user's emotions in a user model in tutoring and decision-aiding systems and in games; and a number of other applications.

There is also a lack of clarity regarding what affective states are modeled. The term 'emotion' in affective models can refer to emotions proper (short, transient states), moods, mixed states such as attitudes, and frequently states that are not considered to be emotions by psychologists (e.g., confusion, flow).

Emotion models also vary greatly in terms of the specific roles of emotions that are being implemented. These may include intrapsychic roles, such as goal management and goal selection, resource allocation and subsystem coordination, as well as interpersonal roles, such as communication and coordination among agents, and among virtual agents and humans.

One of the consequences of the existing terminological vagueness is that when we begin to read a paper addressing 'emotion modeling', we don't really know what to expect. The paper could just as easily describe details of facial expression generation, affective speech synthesis, black-box models mapping domain-specific stimuli onto emotions, or decision-utility formalisms evaluating behavioral alternatives. A more serious consequence of a lack of clear terminology is a lack of design guidelines regarding how to model a particular affective phenomenon of interest: What are the computational tasks that must be implemented? Which theories are most appropriate for a given model? Are these theories specified at an adequate level of resolution to support a computational implementation? What are the associated representational and reasoning requirements, and alternatives? What data are required from the empirical literature? And are these data readily available?

The lack of consistent, clear terminology also makes it difficult to compare approaches, in terms of their theoretical grounding, their modeling requirements, and their theoretical explanatory capabilities and their effectiveness in particular applications.

1.1 Objectives: Computational Analytical Framework and Design Guidelines for Emotion Modeling

The purpose of this chapter is twofold. *First*, to outline a computational analytical framework for emotion modeling, consisting of multiple-levels of description of the processes and representations required to model emotion generation and emotion effects. *Second*, to suggest how this framework can serve as a basis for developing a set of guidelines for more systematic design, analysis and comparison of emotion models. The latter is particularly important, since emotion modeling, particularly in the case of research models, requires communication among multiple disciplines (computational scientists, psychologists, neuroscientists).

By emphasizing the generic computational tasks necessary to model emotions, the proposed computational analytical framework can facilitate communication among different disciplines, which have