

Chapter 8.15

Engineering Emotionally Intelligent Agents

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ABSTRACT

Interacting with intelligence in an ever-changing environment calls for exceptional performances from artificial beings. One mechanism explored to produce intuitive-like behavior in artificial intelligence applications is emotion. This chapter examines the engineering of a mechanism that synthesizes and processes an artificial agent's internal emotional states: the Affective Space. Through use of the affective space, an agent can predict the effect certain behaviors will have on its emotional state and, in turn, decide how to behave. Furthermore, an agent can use the emotions produced from its behavior to update its beliefs about particular entities and events. This chapter explores the psychological theory used to structure the affective space, the way in which the strength of emotional states can be diminished over time,

how emotions influence an agent's perception, and the way in which an agent can migrate from one emotional state to another.

INTRODUCTION

This chapter examines the affective, core mechanism of the Emotionally Motivated Artificial Intelligence (EMAI) architecture: the *Affective Space*. The design of the affective space is motivated by research into the affective agent domain and the identification of the shortage of agent architectures that have the capacity for decision making influenced by a mechanism that simulates human emotional intelligence (Goleman, 1995). Picard (1997) affirms the importance of this type of emotionally influenced decision making in computers. She suggests that if affective deci-

sion making were integrated into computers, it would provide a competent solution to emulating the intelligence of humans, where decisions are often made with insufficient knowledge, limited memory, and relatively slow processing speeds. Emotions are an integral part of human decision making, and by giving machines a similar mechanism, it could help in problem solving, where options cannot be fully explored, data is incomplete, and processing time is short.

In recent times, there have been a number of architectures designed to produce artificial agents capable of expressing and processing emotions [Silas T Dog (Blumberg, 1997), PETEEI (El-Nasr, 1998), EBC Framework (Velasquez, 1999), Emotional Agents (Reilly, 1996), and Creatures (Grand et al., 1997)]. These models cover a wide range of affective phenomena and differ broadly between implementations. As a complete examination of these architectures would constitute a publication in its own right, a comprehensive review of these models will not appear in this chapter.

This chapter begins by examining a brief overview of the EMAI architecture. This is followed with an in-depth examination of the affective space; the architecture's primary emotion-producing mechanism. The chapter continues by examining how emotions are produced and processed by the affective space. Finally, an examination of some future trends for the use of emotional agents is given.

OVERVIEW OF THE EMAI ARCHITECTURE

The EMAI architecture consists of several major processing and knowledge representation areas. These areas work together in a complex network of information gathering, manipulating, and updating. As shown in Figure 1, any agent implemented using the EMAI architecture receives external sensory data from its environment. It also processes internal sensory data from the Motivational Drive Generator in the Knowledge Area. Internal State Registers simulate low-level

biological mechanisms (such as hunger and fatigue). The sensory processor and the affective space integrate both types of sensory data into the agent's belief system via an emotional filtering process. Sensory input (internal and external) received by the sensory processor may activate goals in the agent. The goals are processed by the agent's constructive area, where plans are chosen that will satisfy these goals. These plans are generated by the Event Space Generator, which generates a series of competing events that could be performed by the agent to satisfy its goals. Before the agent schedules the events for execution in the Deliberate Area, each event is ordered by the Intention Generator in collaboration with the affective space and sorted from most *liked* to least *liked*. Once the agent has the list of events sorted by emotional affect, the behavior actuator begins executing them in order. The events executed by the behavior actuator at any moment in time become the EMAI agent's outward behavior.

Although the goal-orientated nature of the EMAI architecture is equally as important as the emotional mechanisms, the focus of this chapter is on the engineering of the emotional aspects of the architecture, therefore, goals and plans will not be discussed here. For further information on the goal setting and planning mechanisms in EMAI architecture, the reader is encouraged to see Baillie (2002).

The affective space, shown in Figure 1, is the focal point of the agent architecture. The affective space acts as an emotional filter that influences an EMAI agent's perception of its beliefs and the environment and, as a consequence, how it behaves. While there have been a number of emotional agents that have preceded EMAI, none have structured emotions in the unrivaled multidimensional sense as does the EMAI's affective space.

THE AFFECTIVE SPACE

The affective space is a new and unique concept in the domain of affective computing. Smith and

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