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Emotional Models:
Types and Applications

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ABSTRACT

Emotion modeling has gained attention for almost two decades now due to the rapid growth of affective computing (AC). AC aims to detect and respond to the end-user's emotions by devices and computers. Despite the hard efforts being directed to emotion modeling with numerous tries to build different models of emotions, emotion modeling remains an art with a lack of consistency and clarity regarding the exact meaning of emotion modeling. This review deconstructs the vagueness of the term 'emotion modeling' by discussing the various types and categories of emotion modeling, including computational models and its categories—emotion generation and emotion effects—and emotion representation models and its categories—categorical, dimensional, and componential models. This review deals with applications associated with each type of emotion model including artificial intelligence and robotics architecture, computer-human interaction applications of the computational models, and emotion classification and affect-aware applications such as video games and tutoring systems applications of emotion representation models.

KEYWORDS

Affect-Aware Applications, Affective Computing, Computational Models, Emotion Modeling, Emotion Representation Models

INTRODUCTION

Emotions have an effective impact on biological agent's behavior and cognitive processes, such as decision making, attention, and memory. Nevertheless, there is no scientific agreement on a common definition of emotions due the different viewpoints of how to understand emotions and the complexity of the human emotions. On the contrary, there is an agreement on a set of emotions' characteristics including emotions having a neural infrastructure and emotions motivate cognition and action as well as recruit response systems. Emotions can be divided into two types, namely basic emotions and dynamic emotions or emotions schemas(Izard, 2009). Basic emotions are known as emotions with old neurobiological substrates, capacity for expressive, and an evolved feeling component (Izard, 2007). Although, dynamic emotions are known as emotions with higher order cognition and dynamic interplay (Izard, 2007).The term emotion in general includes both basic emotions and dynamic emotions.

A critical feature of emotions is their multiple modalities. Emotions can be viewed across four modalities, including behavioral/ expressive modality, somatic/ physiological modality, cognitive / interpretive modality, and experiential / subjective modality. Behavioral/ expressive modality is the most familiar one associated with expressive and action-oriented characteristics, such as facial expressions, speech, gestures and behavior choices (Hudlicka, 2008). The somatic/ physiological modality is responsible for behavior and cognition. The cognitive/ interpretive modality is frequently

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used in the appraisal theories, the base of emotion generation models, as will be discussed below. Emotions have significant impacts on biological agents; as emotions control the survival behaviors, and human balance, they also enable adaptive behavior in different environments, such as social behavior. An additional aspect of emotions is the theories of motivations, which can be categorized as three different viewpoints, namely physiological, neurological, and cognitive. Neurological theories propose that the brain actions resulting in emotional states. Physiological theories suggest that the human body responses which resulting in emotions. The last viewpoint in terms of cognitive theories and suggest that thoughts and other mental activities is the motivation of the emotions.

Many theories have been proposed in the last two centuries to address the nature of emotions and why we experience emotions. One of the most famous studies was reported James-Lange theory in 1884 who defines "what is an emotion?", his theory proposed that bodily activity produces emotion not the opposite. Later in 1927, Cannon Bard criticized James theory, where he denied that the body can generate emotions, based on the slow of visceral changes, and their occurrence in both non emotional and emotional states. An additional theory was Lazarus theory that states that thoughts must come before any emotions, therefore you must first think about your situation before you can experience an emotion (Gendron, 2009).

Lately, severe attention was directed toward the study of emotions especially because of the appearance of "Affective Computing" term (Broekens, 2010). AC is trend to have an emotional human-computer interaction in which the computer or the device will be able to detect and respond to the end-user's emotions which finally leads to a more useful, enjoyable and special experience for the user (Zohora, 2016) (Tian, 2018). For a successful affective computing, there are three processes to be done, namely emotion recognition, emotion elicitation and the emotional behavior generation. The emotions recognition ability can be considered as the crucial evaluation of the AC system as the right emotion detection serves the effectiveness of human-computer communication (Yang, 2019); consequently huge attention is paid toward the emotion recognition process (Maria, 2019). In addition, emotion recognition has applications in many fields as social security, health care, safe driving and help advertisers and content creators to sell their products more effectively. Emotion recognition methods can be divided into two categories: Emotion recognition from physical signals such as speech, gesture, and facial expression, which is easy to collect but has a disadvantage of unreliability. The other method is the emotion recognition using physiological signals, including Electroencephalogram (EEG), Electrocardiogram (ECG), Electromyography (EMG), Galvanic Skin Response (GSR), Temperature (T), and Respiration (RSP).

For emotion recognition, emotions should be accessed and defined clearly as an application of emotion modeling. Emotion modeling gained huge attention for almost two decades now with a number of stand-alone models presented by several researchers, but in spite of these efforts emotion modeling still a problematic topic due to the lack of clarity regarding the exact meaning of emotion modeling. There are a number of definitions of emotion modeling; it may be defined as "the dynamic generation of emotion via black-box models that map specific stimuli onto associated emotion". It can mean "modeling the effects of emotions on decision-making and behavior selection. It can also mean generation facial expression, gestures or movements depicting specific emotion in synthetic agent or robot". Additional impediment is the lack of rules guiding the design process and standards available to guide the modeling process in addition to few tools exist to support efficient model development which make the modeling appears as an art with few known rules (Hudlicka, 2008).

Emotion modeling can be divided into two main categories of computational models, namely emotion generation and emotion effects. Each category has a number of computational tasks necessary to be implemented will be explained later in this review. Identification of these tasks is a fine step to develop of more efficient rules guiding emotion modeling and to compare between different models and their usefulness. Emotion models can also be classified given on its purpose to two main categories: applied models and research models. In the case of applied models, it aims to regulate the behavior of robots and gaming characters, and improve human-computer interaction. On the other