

Affective Computing

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Affective computing is the study and development of systems and devices that can recognize, interpret, process, and simulate human affects. It is an interdisciplinary field spanning computer sciences, psychology, and cognitive science. While the origins of the field may be traced as far back as to early philosophical enquiries into emotion, the more modern branch of computer science originated with Rosalind Picard's 1995 paper on affective computing. A motivation for the research is the ability to simulate empathy. The machine should interpret the emotional state of humans and adapt its behaviour to them, giving an appropriate response for those emotions.

Areas of affective computing

Detecting and recognizing emotional information

Detecting emotional information begins with passive sensors which capture data about the user's physical state or behavior without interpreting the input. The data gathered is analogous to the cues humans use to perceive emotions in others. For example, a video camera might capture facial expressions, body posture and gestures, while a microphone might capture speech. Other sensors detect emotional cues by directly measuring physiological data, such as skin temperature and galvanic resistance.

Recognizing emotional information requires the extraction of meaningful patterns from the gathered data. This is done using machine learning techniques that process different modalities speech recognition, natural language processing, or facial expression detection, and produce either labels (i.e. 'confused') or coordinates in a valence-arousal space. The state of the art literature was recently reviewed in:

Emotion in machines

Another area within affective computing is the design of computational devices proposed to exhibit either innate emotional capabilities or that are capable of convincingly simulating emotions. A more practical approach, based on current technological capabilities, is the simulation of emotions in conversational agents in order to enrich and facilitate interactivity between human and machine. While human emotions are often associated with surges in hormones and other neuropeptides, emotions in machines might be associated with abstract states associated with progress (or lack of progress) in autonomous learning systems. In this view, affective emotional states correspond to time-derivatives (perturbations) in the learning curve of an arbitrary learning system.

Marvin Minsky, one of the pioneering computer scientists in artificial intelligence, relates emotions to the broader issues of machine intelligence stating in *The Emotion Machine* that emotion is "not especially different from the processes that we call 'thinking.'"

Technologies of affective computing

Emotional speech

Emotional speech processing recognizes the user's emotional state by analyzing speech patterns. Vocal parameters and prosody features such as pitch variables and speech rate are analyzed through pattern recognition.

Emotional inflection and modulation in synthesized speech, either through phrasing or acoustic features is useful in human-computer interaction. Such capability makes speech natural and expressive. For example a dialog system might modulate its speech to be more puerile if it deems the emotional model of its current user is that of a child.

Facial expression

The detection and processing of facial expression is achieved through various methods such as optical flow, hidden Markov model, neural network processing or active appearance model. More than one modalities can be combined or fused (multimodal recognition, e.g. facial expressions and speech prosody or facial expressions and hand gestures) to provide a more robust estimation of the subject's emotional state.

Body gesture

Body gesture is the position and the changes of the body. There are many proposed methods to detect the body gesture. Hand gestures have been a common focus of body gesture detection, apparentness methods and 3-D modeling methods are traditionally used.

Visual aesthetics

Aesthetics, in the world of art and photography, refers to the principles of the nature and appreciation of beauty. Judging beauty and other aesthetic qualities is a highly subjective task. Computer scientists at Penn State treat the challenge of automatically inferring aesthetic quality of pictures using their visual content as a machine learning problem, with a peer-rated on-line photo sharing website as data source. They extract certain visual features based on the intuition that they can discriminate between aesthetically pleasing and displeasing images.

Potential applications

In e-learning applications, affective computing can be used to adjust the presentation style of a computerized tutor when a learner is bored, interested, frustrated, or pleased. Psychological health

services, i.e. counseling, benefit from affective computing applications when determining a client's emotional state. Affective computing sends a message via color or sound to express an emotional state to others.

Robotic systems capable of processing affective information exhibit higher flexibility while one works in uncertain or complex environments. Companion devices, such as digital pets, use affective computing abilities to enhance realism and provide a higher degree of autonomy.

Other potential applications are centered around social monitoring. For example, a car can monitor the emotion of all occupants and engage in additional safety measures, such as alerting other vehicles if it detects the driver to be angry. Affective computing has potential applications in human computer interaction, such as affective mirrors allowing the user to see how he or she performs; emotion monitoring agents sending a warning before one sends an angry email; or even music players selecting tracks based on mood.

Affective computing is also being applied to the development of communicative technologies for use by people with autism.