Emotional Information Space in Designing AI Technologies

Johanna Silvennoinen, Pertti Saariluoma

University of Jyvaskyla, Faculty of Information Technology
FI-40014 University of Jyvaskyla, Finland

ABSTRACT

Current and future AI design needs to recognize the intertwined nature of cognition and affect to design more human-like intelligent systems. The majority of current AI design focuses on cognitive information processes and knowledge. However, human action and human-like actions must also consider the emotional aspects of the environment. We present the concept of emotional information space, which incorporates all issues within a certain environment with cognitively appraised affective meanings and the ability to encode these information contents into designing emotionally intelligent technologies.

Keywords: Emotional Information Space, Emotional Information Processing, AI Design, Intelligent Technologies, Cognition and Emotion

INTRODUCTION

Modern research and design processes are getting more complex than they used to be. Instead of rushing to solve problems empirically, some researchers think it is worthwhile first to think about the foundations of a paradigm intended to be built around some concrete problem (Chalmers, 2020, Isaac, 2020, Saariluoma, 1997). Such a way of working in research and design can be called conceptual engineering. Here, we conduct heteronymous conceptual engineering (Chalmers, 2020) in creating a novel concept: emotional information space, which integrates different levels and approaches of emotional meanings within an information space into AI design. This necessitates analyzing the foundations of creating emotionally interacting intelligent technologies.

In traditional electromechanical technologies, main design solutions have relied on controlled use of materials, mechanics, and energy. However, intelligent technologies such as AI and robots are much more complex due to their ability to control their steering and information processes (Boden, 2016, Wiener, 1948). Thus, AI differs from traditional electromechanical technology in its capacity to guide its actions independently from immediate human control.

For this reason, intelligent technologies often operate in environments which components make sense to the system. These components can have emotional aspects. For example, one can be afraid of animals and avoid them when walking in a forest. The components can be verbal messages or pictures, but there is no obstacle for them to be any kind of emotionally meaningful and sense-making semiotic objects. Moreover, intelligent technologies do not operate only in space and time, but they can also be actively and intelligently involved in human information space. This space has cognitive and emotional dimensions in human information processing, and such spaces require effective encoding of these dimensions to be incorporated into AI design. Emotional information space as an umbrella term integrates different levels and approaches of emotional meanings within an information space into AI design.

In the human mind, cognitive and affective processes are intertwined (Frijda, 1986, Panksepp, 1998, Ortony et al. 1990), and for machines to understand operations of the human mind, the ability to encode emotional aspects of the given information is required (Kerruish, 2021, Jokinen & Silvennoinen, 2020, Saariluoma, 2020). This information can have any physical semiotics (Saariluoma & Rousi, 2015). It can be encoded in language but as well in expressions or prosody. Acknowledging the intertwined relation of cognition and emotion is essential for the future design of intelligent systems.

Much conceptual engineering is required now, as it may give clarity and pave the way for future design work. In addition, AI research is extensively two-fold; a wide research gap between technically and societally oriented research streams rule the research field (Ligo et al. 2021). Incorporating the emotional dimension in the design of intelligent technologies can narrow this gap, as in emotional information spaces, societal issues (e.g., ethics, moral implications, and public engagement needs) are inherited in emotional interaction that can be manifested with different technological outcomes. The focus of this paper is to explicate conceptual issues associated with emotional and cognitive information processing and describe intelligent systems design within emotional information space.

EMOTIONS IN MIND

Emotional processes are essential because they play a central role in directing human actions

(Power & Dalgleish, 1997, Saariluoma, 2020). In human mental representations, emotions can be seen as “emotional states”, which refer to emotional information in the mind. Depending on how people have encoded in their mind some social situation, and persons in this situation, for example, they may avoid the situation or pursuit towards it. In the first alternative, their emotional state is negative, while in the latter, it is positive.

Emotional states often explain people’s ways of experiencing, doing, and thinking. In an optimistic emotional state, people believe they are succeeding in achieving goals, depressed they may not even go to try (Seligman, 1990). An enraged person may fall into the power of his immediate emotional state to such an extent that he kills another person in the power of a sudden emotional turmoil. He may regret his actions after a while, but it is no longer possible to remove the effect of the emotional state. The prevailing emotional state is thus a key factor in explaining the nature of behaviour.

A core issue in analyzing any emotional state is its emotional information contents, which arises in the mind when a person meets the part of the environment. Emotional contents refer, on the one hand, emotional valence and, on the other emotional theme. The first concept entails positivity and negativity of some emotion. Joy is positive, sorrow is negative, admiration is positive, and disgust is negative. The concept of theme refers to the contents of an emotion. Thus, fury is different from envy, and their representational references are different.

Emotional states begin with the activation of emotions. These are activated on the basis of cognitive situation analysis in their typical operating situations. This process is typically called appraisal. Appraisal theory posits that emotions result from a cognitive evaluation of the significance of an event within a certain environment (Frijda, 1988, Scherer, 2009). Emotions emerge in relation to objects; thus, emotions are object-directed and intentional (Frijda, 1984). If in the forest we come across a bear, we consider the situation dangerous, and our emotional reaction is fear. Still, in a Zoo, a similar situation is curious as bars prevent bears from attacking us. When we know the situation is harmless, the emotional reactions are quite different.

Appraisal process integrates information from different information sources. Firstly, perceptual information source includes aspects of directly detectable stimuli. Secondly, associative information source involves fast and automatic retrieval of memory contents to associative meanings of events within a context. Thirdly, reasoning processes construct linguistically encoded meanings (Smith & Kirby, 2001). For instance, in appraising warmness of material, a relatively direct process of touch perception and temperature recognition is involved. However, to appraise a material as useful and elegant requires a more complex process of retrieving associative mental information contents and reasoning processes (Silvennoinen et al. 2015).

Human action is navigating in the space of mental representations of situations activated in their minds. Some situations and some situational elements call some emotional states. To activate appraisal, one needs to have a cognitive representation of a situation and its core elements. Together cognition and emotions create the prevailing mental representation in a person's mind, and this representation controls actions.

INTELLIGENCE AND MACHINES

Technologies are developed and justified to help people achieve their goals in their lives and thus to raise the quality of human life. Traditional electromechanical technologies have been based on modifying and manipulating matter and energy. Axes have made it possible to cut trees and steam engines to transform goods on time from one place to another (Bernal, 1969).

Intelligent technologies represent a new technological revolution. Intelligent technologies change the steering of tools. When it has for millennia been necessary that people intelligently steer the actions of work processes, modern automatization and autonomization, as well as robotics relying on the two previous ideas, make it possible for people to leave actions for AI systems and machines. Technical tools can today operate independently of immediate human control as they have the capacity to intelligently control the work processes.

Modern intelligent systems can carry out complex tasks that previously required information processing from a human mind. These emerging technological applications have revolutionary implications for the industrial processes, office automation, intelligent medicine, teaching, autonomous traffic systems and intelligent finance of the future. The new technologies can even improve creativity as they can generate new information states unknown to people before.

Intelligent technologies are masters of fast routine information processing, logical inferences, and problem-solving. These systems can make decisions and choices between sense-making courses of action. They can even learn to make classifications of their own, so people cannot predict the information states they can generate. Their capacity to engage in selective information processing makes it possible for modern AI-based systems to compare the values of different information states to select the one that is most fit for the purpose. Selection between alternative courses of action is important here. People use emotions in putting things in preference order. People decide on the ground of their emotions the value of some person, object, event or situation to themselves (Frijda, 1986). This is why emotional information processing is very human, but it is not totally alien to machines either. Machines can register emotionally activated events in environments (Boden, 2016, Simon, 1967). Modern sensory technology makes it possible to encode human emotional states (Ko, 2018). Thus, intelligent technologies can interact with emotional situations.

EMOTIONAL INFORMATION SPACES

In any situation, emotions can be activated on the ground of cognitive analysis. Some people, objects or events are negative; some are positive. Thus, in human mental representations or in machine situational representations, components and their combinations have emotional values. The system of emotional values can be seen as a kind of emotional map or space in which affective elements can be seen as attributes of situations.

Any tree in front of a person has form and colour as its attributes. However, the tree can also have emotional attributes. For example, in Brueghel's famous "Hunters in the snow", sad trees create their element in the depicted situation. Similarly, in any situation, elements have their emotional values as much as they have forms, colours, ethical rules or any cognitive attributes. This means that it is in principle possible to build an emotional map of situations in which a robot operates. One can call such situational representations as emotional information space.

The foundations of emotional information space are based on emotional information processing theories. Emotional information processing, for example, in decision-making, has been referred to as irrational and intuitional, whereas conscious, cognitive, and analytical as rational behaviour (Simon, 1987). Information processing theories have not focused on the interaction of cognition with emotion, even though, in human behaviour, emotion has a significant influence on cognitive processes. Understanding the human mind requires an understanding of both (Simon, 1967). The importance of emotion in human information processing has slowly started to be acknowledged. Current research stresses the intertwined nature of cognition and emotion (Kret & Bocanegra, 2016). However, concerning AI and the design of intelligent systems, cognitive approaches still play a major role.

From our point of view, it is essential that components of an information space can have and often have emotional meanings. They incorporate valence and different emotional themes (e.g., human faces in information space with emotional themes and robots in elderly care encoding components of their emotional information spaces). For designers, it is evidently important to acknowledge context-specific emotional information spaces when developing emotion-incorporated AI. Thus, the main focus here is on how technology relevant emotional representations are encoded, what we know about these representations and how it is possible to conceptually systematize this domain.

CONCLUSIONS

Conceptual engineering (Chalmers, 2020, Isaac, 2020) can be utilized in mapping and understanding necessities for advancements in designing more human-like intelligent technologies. Here, we presented a concept of emotional information space. Emotional information space integrates different levels and approaches of emotional meanings within an information space into AI design.

The theoretical basis of emotional information space is on human emotional information processing, in which cognitive and affective processes are intertwined (Frijda, 1986, Panksepp, 1998, Ortony et al. 1990). The relation of cognition and affect can be explicated with appraisal theory. Appraisal process unifies information from different information sources: perceptual stimuli, associative information source, and reasoning (Smith & Kirby, 2001). The detection and processing of perceptual stimuli are relatively immediate and direct and does not require complex higher-level mental processes. Associative processing depends on spreading activation, i.e., retrieving relevant information from long-term memory is dependent on the activation of relevant nodes (Anderson, 2000). The appraisal process from the associative source takes more time than from the source of perceptual stimuli. The information source for reasoning occurs under conscious control, constructs meanings, and therefore involves higher-level mental processes.

Understanding operations of the human mind is at the core to encode emotional aspects of given information for machines to process (Kerruish, 2021, Saariluoma, 2020, Jokinen & Silvennoinen, 2020). This information can have any physical semiotics (Saariluoma & Rousi, 2015), such as pictures, sound and verbal messages. Our future research focuses on explicating the ways contents of emotional information space can be elicited, examined and analyzed to be integrated into the design of emotionally intelligent technologies.

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