Emotional thinking as the foundation of consciousness in artificial intelligence

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Abstract
Current theories of artificial intelligence (AI) generally exclude human emotions. The idea at the core of such theories could be described as ‘cognition is computing’; that is, that human psychological and symbolic representations and the operations involved in structuring such representations in human thinking and intelligence can be converted by AI into a series of cognitive symbolic representations and calculations in a manner that simulates human intelligence. However, after decades of development, the cognitive computing doctrine has encountered many difficulties, both in theory and in practice; in particular, it is far from approaching real human intelligence. Real human intelligence runs through the whole process of the emotions. The core and motivation of rational thinking are derived from the emotions. Intelligence without emotion neither exists nor is meaningful. For example, the idea of ‘hot thinking’ proposed by Paul Thagard, a philosopher of cognitive science, discusses the mechanism of the emotions in human cognition and the thinking process. Through an analysis from the perspectives of cognitive neurology, cognitive psychology and social anthropology, this article notes that there may be a type of thinking that could be called ‘emotional thinking’. This type of thinking includes complex emotional factors during the cognitive processes. The term is used to refer to the capacity to process information and use emotions to integrate information in order to arrive at the right decisions and reactions. This type of thinking can be divided into two types according to the role of cognition: positive and negative emotional thinking. That division reflects opposite forces in the cognitive process. In the future, ‘emotional computing’ will cause an important acceleration in the development of AI consciousness. The foundation of AI consciousness is emotional computing based on the simulation of emotional thinking.

Keywords
Emotion, thinking, emotional thinking, AI consciousness, emotional computing

1. Introduction
The current theoretical basis of artificial intelligence (AI) is the doctrine of cognitive computing, which holds that computing lies at the heart of human intelligence. Such a view sees human
intelligence as the calculation of the symbols of mental representation and AI as essentially a computing-based simulation of human thinking. This simulation process is realized by making computer programs through binary algorithmic conversions and then enabling computers and their associated systems to exhibit certain human-like intelligent behaviours through automated control and adaptive changes of the program. This computing-based AI model, however, now faces an insurmountable obstacle: Existing AI machines are still far from approaching real human intelligence, and AI without AI awareness is just ‘artificial+intelligence’ at best. This is due to many practical limitations in the progress of technology, but the imperfection of the theoretical concept is the fundamental factor constraining the true realization of AI in the future. One of the major deficiencies in the theoretical concept is the neglect of emotions in human intelligence. A large body of contemporary research in cognitive science has shown that the human brain does not make a clear distinction between what is ‘emotional’ and what is ‘rational’ when processing information, and that many of our emotions are formed through a suppression of resources by our rational thinking, so there are many similarities between emotion and rationality in terms of the input, processing and feedback of information.

Human intelligence, as an advanced cognitive process, contains not only rational reasoning and decision-making but also many emotional factors and dynamics. Human thinking is an understanding dependent on context, whereas intelligence is a decision-making process based on emotions. Only by bringing the emotional factors into the computationalist paradigm and proposing new cognitive computing methods and theoretical models mixed with emotions will it be possible to achieve a true imitation of human thinking. This type of ‘emotional computing’, which is different from traditional mathematical and theoretical computing and aims to simulate human emotional thinking, has become an important direction for the future development of AI. ‘Emotional computing’ provides the visualization of emotional thinking, and emotional computing based on the simulation of emotional thinking constitutes the foundation for the future of AI.

2. Emotion and the connotation and role of emotional thinking

2.1 Emotion, mood and feeling: Connection and distinction

In ancient Greece, people first used the word ‘pathos’ to express the feeling of sadness produced by tragedy; Latin words with similar meanings include passio and affectio. The word ‘emotion’ is the combination of the prefix ‘e’ and the verb meaning ‘to move’; the literal meaning is to move from one place to another, emphasizing the ability of the emotions to ‘move’ people. Later, the word also included meanings such as disruption and activity, and only after the establishment of modern psychology was it finally used by William James to express the series of changes that occur in an individual’s mental state (Knuuttila and Sihvola, 2014: 463). Therefore, in etymological terms, ‘emotion’, ‘mood’ and ‘feeling’ have a natural proximity to each other, as they all refer to a person’s perceptual experience or mental state.

In the context of contemporary psychology, ‘mood’ refers to an emotional response closely related to biological needs. It is usually used to mark the forms of feelings and has an exogenous character. Mood represents the most general process of emotional response, and both humans and non-human animals can have moods. In contrast, ‘emotion’ is an advanced form of feelings and an emotional reflection of things with stable and deep social meaning. It is usually used to mark the content of feelings and is focused on the subject’s experience of things. Emotion is more implicit, and only humans can have emotions. Emotion includes both the perceptual ability associated with ‘feelings’ and the process of experience associated with ‘sympathy’. It gives expression to the awareness and experience of human beings of their own sensory experience. Feeling is a collective term for the emotional responses associated with specific human needs. It generally encompasses the processes of both moods and emotions and contains the meanings of both concepts.
From the perspective of cognitive science, ‘mood’ refers to a feeling felt by our body and mind when we are in an emotional state, and it is a mixture of perceptions in such an emotional state. As it relates to our body, mood is better seen as the image of an action in our mind rather than the action itself, and it is essentially a reflection of perceptions in our brain. Emotion, in contrast, is a complex and vastly automated programme of actions, consisting of a cognitive scheme that includes specific ideas and patterns. Such actions are largely exhibited by our body, including changes in aspects of the body ranging from facial expressions and body postures to internal body organs. Moreover, emotion is concerned with specific ideas and patterns of thought (Damasio, 2010: 77).

It is evident that mood and emotion both refer to the same process or state, and they both include the elements of body awakening, subjective experience and expressive behaviour. There is no absolute distinction or boundary between them, and what separates them from one another is more of a difference in the description of the state. Emotion can be seen as a relatively stable state of mind that is formed based on multiple mood experiences and can be expressed in the form of moods. Mood is the basis and external expression of emotion, whereas emotion is the deeper form and main content of mood. Emotion is our attitude towards the value of our existence. It includes not only complex aspects of consciousness such as beliefs and ideals but also the interpretation of our own personal state and external environment and our choice of reactions. Emotion is also a purpose and an attitude that is closely linked to cognitive behaviours, needs and evaluations. Therefore, emotion contains a common connotation, and it is inseparable from the thinking activities, moral behaviour, survival state, aesthetic experience and practical activities of human beings (Cui, 2006: 150–151).

2.2 Connotations and forms of emotional thinking

Thinking in the context of cognitive science refers to an indirect, generalized cognitive activity that exists in the brain-based cognitive system and is inferred from human behaviour. Thinking is also a series of operational processes within the cognitive system. Therefore, thinking is an ‘indirect, generalized cognitive process directed towards problem-solving’ (Wang, 1992: 4). Thinking is a series of activities performed by our brain and requires internal and external representations through multiple forms. In this sense, thinking is a system of mental representations of our knowledge, and its content and purpose are to describe the state of the real or possible world. As people tend to believe that thinking is a process of decision-making, deduction or conceptualization, it is also an action plan to achieve a goal and a form of memories (Holyoak and Morrison, 2005: 5).

There are two forms of human emotions. One is a person’s internal state or experience, and the other is a person’s outward facial expression and associated actions. This leads to two different definitions of emotion: The first is based on psychological introspection, which considers emotion as the organization of physiological–psychological reactions to the subject’s perceptions of environmental information; the second is based on physiological changes, which considers emotion as a result of the changes in muscles, glands, hormone levels and other somatic signs. It is the disruption caused by our body to our mind and behaviour.

As Paul Thagard (2012: 176) observes, there is much controversy among cognitive scientists about the nature of emotion, and two popular camps have emerged: One sees emotion broadly as a judgement about the general conditions of humans (cognitive judgement); the other stresses the human body’s response to cognition (the brain’s adjustment and adaptation to body changes). Those two views have only captured the source and role of emotions in a certain aspect of the mind or body, but ignored the important role of emotions in mind–body interaction. For this reason, contemporary cognitive psychology believes that emotion should be defined as a mental activity and motivational psychological force consisting of multiple components, a multidimensional quantitative structure and multi-level integration, and interacting with cognition for the purpose of people’s survival, adaptation and interpersonal interaction (Meng, 2005: 4).

Obviously, to bridge the gap between the two conflicting views of mind–body interaction, the importance of emotions in AI research must be duly
recognized. In the words of cognitive scientist Antonio Damasio (2010: 76), in order to truly understand how humans behave and think, it is important to bring emotional factors into the picture. Our study of human consciousness, thinking and psychology will not be complete if we do not pay adequate attention to the emotions and the phenomena hidden within them. The discussion of emotional issues needs to come back to real life, especially on issues concerning values, rewards and punishments, drives and motivations, and necessary feelings. It is based on such a view that we believe thinking should be seen as a series of physiological–psychological activities taking place within a person. It takes our memory as the basis and combines our emotional experiences. It covers a series of our mental activities and reflects our representations of the external environment, which gives it a sense of direction and purpose. In terms of thinking mechanisms and processes, there is a type of ‘emotional thinking’ that encompasses the complex cognitive factors and processes contained in emotions themselves. It refers to the thinking patterns and abilities of human beings to integrate information and form reactions or make decisions through emotions while processing and handling incoming information.

2.3 The division and role of emotional thinking

There are two perspectives in research on emotions in cognitive science. One is typological research, which argues that emotions consist of different basic moods and, therefore, that the core of research on emotions is classification. Traditional philosophical epistemology and psychology have mostly taken this perspective, distinguishing between different types of moods mainly by their external expressions. The other is dimensional research, which divides emotions into positive and negative ones based on their functions. These two methods of division each have their advantages and disadvantages and can be merged to create a division of emotional thinking into positive and negative dimensions.

Positive emotional thinking is a way of thinking that enables the subject to perceive and react to the surrounding environment with appropriate and effective emotions.

Negative emotional thinking is a way of thinking that fails to let the subject perceive or react to the surrounding environment with appropriate and effective emotions and often leads to cognitive bias or thinking mistakes.

Such a division is not the same as the simplistic division of positive and negative emotions because, in some specific situations, positive emotions do not necessarily contribute to thinking. For example, to have a deep understanding and experience of a tragedy, the readers or viewers must associate themselves with the character’s emotion of sadness. Such an emotion, though being perceived as negative in everyday life, can have a positive impact on our mind and cognition in the sense of emotional thinking. Another example is fear, which allows the subject to make quick judgements and reactions under threat (for example, running away). Again, this seemingly negative emotion also plays a positive role in the subject’s cognition and behaviour. In the cross-cutting context of psychology, positive emotional thinking is generated primarily by the feelings of security and satisfaction, whereas negative emotional thinking is generated primarily by the feelings of fear and disgust. Only when these two types of emotional thinking are balanced in a particular environment can the subject have a stable emotional structure and an appropriate structure of emotional thinking to perceive and react to the external environment reasonably.

3. Cognitive neurological proof of emotional thinking

As early as the 19th century, Paul Broca called the cingulate gyrus and the parahippocampal gyrus, which are located at the edge of the cerebral hemispheres adjacent to the mesencephalon, the limbic lobe. Paul Maclean further named the limbic region at the junction between the telencephalon and the mesencephalon the ‘limbic system’, which mainly includes brain areas such as the hippocampus, amygdala, prefrontal cortex, cingulate gyrus and hypothalamus, and argued that the neural structure in the region plays a key role in emotional processing (Cai, 2010: 207). Contemporary research in cognitive neuroscience shows that the emotional experience of humans occurs mainly in the brainstem regulatory system, which includes the insula, amygdala, orbitofrontal cortex and other structures. In particular, the amygdala is a part that is closely
associated with the emotions of fear and anger, yet we still know little about how emotions interact with motives and moods, and our knowledge about how neurochemistry adjusts emotions and other mental states is also limited. Therefore, it is both urgent and important to study the role of emotions in cognitive development (Dolan, 2002).

Michael Gazzaniga (2011: 332), a cognitive neuroscientist, has proposed the distribution of the four basic emotions and their corresponding brain areas and functions shown in Table 1.

This emotional correspondence, which is based on the division and collaboration of brain areas, is also very much in line with the cognitive tradition passed down from the era of Plato: Reason is at the centre of the brain, and emotion is at the periphery. Cognitive neurological studies also, to a certain degree, support this presupposition, arguing that the main control areas of emotions should be concentrated in the limbic cortical system, especially the prefrontal cortex, ventral medial prefrontal cortex and orbitofrontal cortex, amygdala and hippocampus. Each brain area is linked to a different emotion and is responsible for a particular type of emotional thinking.

### 3.1 The prefrontal cortex system mainly controls and regulates the semantic information in intelligence

Language is a direct reflection of thought in the real world, and the brain area for the function of language is considered the material foundation for the existence of thought. As early as 1861, Broca discovered through autopsies of patients with expressive aphasia that the language centre is located in the posterior part of the inferior frontal gyrus in the frontal lobe of the brain’s left hemisphere, which was later named ‘Broca’s area’ (Draaisma, 2009: 93). By examining the blood flow at the local prefrontal cortex, contemporary neuroscientists have proved that the left inferior prefrontal cortex is indeed an important area for extracting semantic information and that brain changes caused by strong emotions tend to alter the quality and utility of decisions (Drevets and Raichle, 1998). Because of this particular feature, the prefrontal cortex is closely related to both language ability and emotional stimulation, and its ability to process semantic information also marks a notable distinction between humans and other animals. Therefore, it also proves that the ability to reflect thinking through language and associate with emotions does exist in this area.

### 3.2 Emotional thinking is mainly concentrated in the ventral medial prefrontal cortex and orbitofrontal cortex

The key function of the ventral medial prefrontal cortex and orbitofrontal cortex is to encode and represent changes in the emotions related to social life and to calculate the emotional value of the current situation as well as the reactions or actions to be taken based on that calculation (Xu, 2008: 45–48). Damage to the ventral medial prefrontal cortex, which is mainly responsible for controlling the feeling of trust, makes it easier for people to believe others. It also explains why smart patients with damage to this area can fall into the trap of seemingly evident deceptions. The orbitofrontal cortex, in contrast, is the dominant neural area that produces the sense of regret—a feeling that is mainly caused by upward counterfactual thinking. Moreover, the orbitofrontal cortex is also associated with the generation of emotions such as pleasure, embarrassment, anger and sadness. In summary, their function is to guide our behaviour with our emotional responses and to control outbursts of the corresponding emotions in different social contexts.

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**Table 1.** Four types of emotions and their corresponding brain areas and functions.

| Type of emotion | Corresponding brain area                                                                 | Function                     |
|-----------------|------------------------------------------------------------------------------------------|------------------------------|
| Fear            | Amygdala                                                                                 | Learning, avoiding           |
| Anger           | Orbitofrontal cortex, anterior cingulate gyrus                                           | Marking violation of social norms |
| Sadness         | Amygdala, right temporal pole                                                            | Retreating                   |
| Disgust         | Anterior insula, anterior cingulate gyrus                                                 | Evading                      |

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3.3 The amygdala is the rapid-response core for processing basic emotional information

The amygdala is particularly sensitive to the threat of fear, as discovered by neuroscientist Joseph LeDoux through brain imaging studies of monkeys with damage to the amygdala. He argues that the amygdala has the ability to react even before the cerebral cortex has finished processing, and he sees the amygdala as a hub for processing emotional information that analyses the sensory information acquired by the body to determine whether it contains emotional content and then links it to the rest of the brain to make a proper reaction. The amygdala receives sensory information from two sources: One is the sensory information from the audiovisual cortex, and the other is the sensory information from the thalamus. Its judgement of emotional content depends not only on the sensory information obtained from the outside but also on information inside the brain (memory, imagination and so on), which shows that the amygdala already has the ability and function to perform thinking of a certain kind. Based on that observation, LeDoux proposed the dual-channel theory of emotion transmission: In the first channel, the external information is analysed by the neocortex before reaching the amygdala; in the second channel, the information reaches the amygdala directly and triggers reactions. Behavioural assessment of patients suffering from damage to the amygdala on both sides shows that almost all of them have lost the ability to judge social threats (especially face recognition), and that they see all faces (even those that are grim or apparently aggressive) as approachable and trustworthy. It is, therefore, possible to expand the evading function of the amygdala to the level of socio-emotional cognition and conclude that it also plays a critical role in the judgement of others’ intentions, beliefs and other emotional processes (Fine et al., 2001).

3.4 The role of the hippocampus in emotional thinking is mainly reflected in the storage and awakening of emotional memories together with the amygdala

The hippocampus is mainly responsible for preserving declarative memories and recalling complex events in the past, whereas the amygdala is responsible for judging the emotional value of information extracted from the hippocampus. The amygdala performs pre-attentive processing of emotional information and internalizes it into implicit memories. Together with the non-emotional semantic processing of the hippocampus, these form a person’s situational memory of past events. In this sense, the content of the memory information provided by the hippocampus constitutes an intrinsic source of information for emotional thinking. Cognitive neuroscientists have given a vivid example of the relationship between the roles of the hippocampus and the amygdala in the cognitive process: The hippocampus recognizes who your cousin is from the information transmitted by the optic nerve, but the amygdala reminds you that you do not, in fact, like her. This is a typical process of emotional thinking. Particularly when it comes to the people and things that are close to us, our perception is deeply affected by emotional factors. We might not feel these factors all the time, but their existence is real.

In a nutshell, the study of the location of different types of emotions in the limbic system of the human brain proves that most of the cognitive activities carried out in the human brain contain certain emotional factors, and that emotional factors often play a critical role in planning and decision-making. There is no such thing as ‘pure rational thinking’. The only difference between rational thinking and emotional thinking lies in the weight and duration of emotional factors. From a neuroscientific point of view, emotions are often induced by specific stimulations, which then spread rapidly to the corresponding cortical areas in the body and brain and trigger the emotional experience. It is important to note that the changes in the sensory signals, which are transmitted to the brain and processed by the body and the brain, are the real source of our emotional experiences (Damasio, 2010: 77). As far as thinking is concerned, the role of emotion involves not only anticipation but also the making of final decisions. Rational people who lack emotions are more likely to make judgements against themselves, as indicated by fMRI (functional magnetic resonance imaging) scans of some brain-injured patients with damage to the ventral prefrontal cortex, who have been found to tend to make decisions against themselves. This shows that reason without emotion not only loses its direction but also loses its value.
4. Cognitive psychological proof of emotional thinking

Emotional thinking is an important part of human psychology and the structure of personality, as reflected in the following three aspects.

4.1 Emotion is the starting point of human consciousness and memory

In the brain’s cognitive and thinking process, emotions are involved not only as a psychological background but also often as the primary trigger of consciousness. Bernard Baars (2014: 24), a cognitive psychologist, once compared consciousness to a spotlight in the theatre of the mind, where the light shines on what the person notices as consciousness. Whereas thinking is considered an advanced stage of consciousness, emotion can be seen as the initial source of the light of consciousness and as controlling its direction and content. This emotion-controlled thinking pattern and ability are the basis of the existence of emotional thinking in cognitive psychology. From the perspective of information processing, different states of emotional thinking can facilitate or slow down brain processing and can also influence the choice and direction of processing through the adjustment of body functions.

The role of emotion in memory is reflected in its ability to influence both the way events are stored and, more importantly, the reconstruction of events during recollection. Emotion strengthens our memories of events, and events with strong emotional attachments are often easier to recall than neutral events and can be recalled in more precise detail. When memory is encoded and stored, not only is the event itself encoded but the attached emotions will also be labelled and stored. The emotional labels are sometimes given higher priority than the events when relevant information needs to be retrieved. This constitutes what is known as ‘situational memory’—a highly personalized memory of the unique scenes in our daily life. Combining all the associated information we have about particular events, people, times and places, such a memory is essentially an internal experience of the things we have experienced (Rowlands, 2004: 123). The process of recollection is like putting a broken vase back together rather than playing a movie that we have seen before. We find our memories vivid and distinct, but this is only an illusion; memories are not real records of past events, but the results of reconstructions in our own imagination. This is why different people have very different recollections of the same event, even though their accounts are all considered to be true and reliable. The process of memory reconstruction is naturally driven and shaped by emotional thinking, which forms the psychological basis of our cognitive content.

4.2 Emotional thinking is the most important basic decision-making ability for humans

Judgement and decision-making in the case of complex problems have always been regarded as the core ability and highest form of thinking. Normally, we make judgements and decisions in two ways: One is accurate and reliable but takes a longer time (rational logic), and the other is fast but unreliable (sensory emotion). Both are decisive abilities that have been developed and refined as our body evolved, and reason and emotion can be seen as two complementary systems that work together to help us make decisions. When there is sufficient time and information, the accuracy and reliability of judgement should be a top-order priority, and we can rely on our reason to make detailed analysis and judgement; when time is limited and information insufficient, the accuracy of judgement should give way to effectiveness, and that is the time for us to make a quick judgement with emotional thinking.

4.3 Emotional thinking is an important part of personality and is also important in the development of human intelligence

If the growth of an infant can be seen as a replay of the evolution of the human species, the development of the child’s mind can also be seen as a microcosm of the evolution of human thinking. Newborns cannot survive on their own, but they are not completely passive and unconditionally
nurtured by adults. They are able to feel information inside and outside their bodies and express the information with simple emotions—an ability they have inherited from their ancestors. Even without fully developed language skills, they can quickly establish intimate connections with people around them through actions, expressions and sounds. In this sense, we can say that infants’ emotional abilities are the first effective tools of mental adaptation acquired by humans after coming into this world. Despite the simple content and form, they also contain basic encoding and storage processes. In terms of the cognitive process, emotion should be understood as a strategic signal, especially in the process of preference intensity encoding. Most of the emotions are directional and preference-based, which can be traced back to the intimate interactions humans establish with their caregivers as infants; the feeling of dependence arising from those interactions continues into adulthood (Menary, 2010: 315). This shows that emotion is an important mental tool genetically acquired by humans to adapt and survive during infancy, and the ability of emotional thinking is its natural result. As socialization progresses, infants’ emotions develop along with their language skills. It is through the interaction between and the influence of emotion and cognition that a person is able to grow his or her inner psychological qualities and develop a complete personality over time.

5. Social anthropological proof of emotional thinking

All the above analyses of the physical and psychological foundation of emotional thinking in cognition take the individual person as the basic unit, but, in reality, a person is never an isolated unit, and our body and mind are always exchanging information with the external environment. Because each person is a member of society, a person’s emotional thinking is going through constant changes, not only for the purpose of evolution but also for the purpose of social interaction and unity. Evidence of the existence of emotional thinking in human society can be found in the following three aspects.

5.1 Emotional thinking is a necessary psychological tool developed by humans for the purpose of survival and adaptation to the environment

Although not all vertebrates have social emotions, most of them have certain emotional expressions, and some advanced mammals may also take actions with certain emotional colours. It is generally believed that the generation of basic emotions such as happiness, anger, sadness and fear synchronizes with vertebrates’ brains, which can be traced back to about 500 million years ago, whereas the history of advanced cognitive emotions is no more than 60 million years old. Darwin, who first studied the evolutionary characteristics of the emotions, believed that many emotional reactions of humans are also the result of evolution from our animal ancestors. For instance, when humans face fear or want to express anger, their hair will also stand up. In the meantime, human emotions are also acquired in the process of living with other people and are shaped by the surrounding environment and the learning preferences of individual people, especially during infancy and childhood, which are periods when family education plays a critical role (Evans, 2013: 167).

5.2 Emotional thinking is an effective means of cross-cultural and cross-generational communication for humans

It is the commonality and relative stability of emotions that make interpersonal communication possible and enable us to transcend the barriers between cultures and achieve a broader connection. In the late 1960s, anthropologist Paul Ekman conducted a long-term survey in a remote area of New Guinea called Fore. He found that people in that area had no written language and had not seen Western pictures or movies before, so it was impossible for them to understand Westerners’ emotions. He told the Fore people some stories and showed them pictures of Western expressions, and the Fore people were able to roughly connect the storyline using the pictures of expressions. This shows that there are certain innate emotions that are not confined by racial boundaries but are shared by all humans.
Ekman called them ‘basic emotions’. Those basic emotions include pleasure, pain, anger, fear, surprise and disgust, and they are present in almost any culture and do not appear to be acquired but are instead inherent in the human brain.

Some experiments have shown that even babies who are born blind can make typical facial expressions, such as smiles and frowns, that convey such emotions. When we say that certain personalities or emotions are innate, we mean that they are naturally born. In other words, anyone can have basic emotions and expressions as soon as they are born and when their basic survival needs are satisfied. Similarly, language can also be said to be an innate human ability, and an infant with the normal physiological function of language does not need much specialized training—spending some time with people who also have language skills is the only thing needed for them to develop the ability to learn and use language (Drevets and Raichle, 1998). It is the very existence of emotional thinking that allows humans to conduct basic information exchange across cultures and generations and enables societies that do not have written language to maintain basic positive functioning.

5.3 The rationality of collective decision-making in human society is based on the social nature of emotional thinking

For highly socialized creatures such as humans, the emotions of individuals in a group are often amplified. On the one hand, a person’s internal senses will change in response to emotional guidance, which, in turn, leads the body to take or avoid certain actions. On the other hand, the external manifestation of emotions in the organism provides the necessary information for others to empathize with us and understand our emotions and experiences. This feeling of empathy creates a sense of belonging and identity, often leading to a significant increase in the ability to engage in emotional thinking.

In social practices, however, we do not trust this socialized emotional thinking and tend to believe that the decision a person makes on their own is inevitably clouded by emotions. Therefore, we try to increase the rational elements of our decisions by increasing the number of people involved, and trust in collective decision-making has thus become the cornerstone of contemporary democracy. Does this presupposition that 100 people are more rational and reasonable than one person really hold true? Social psychologists have arrived at a negative answer to this question through an elaborate experiment. In most situations, especially when time and information are both limited, the intuitive judgements made by subjects based on their emotions often have higher accuracy, which suggests that emotion-based decision-making is effective. If we think collective decision-making is a better sign of social progress than a one-person dictatorship, and the verdict passed by a public jury represents greater fairness and justice than a ruling made by a single judge, it is precisely because, compared to individual persons, a group of people tends to have a greater ability to engage in emotional thinking, not less ability, as people may assume. Rather than believing that collective decision-making has more rational components, we prefer to believe that it is more conscientious and reliable. Essentially, that belief is more of the result of our emotional expectations than the result of rational analysis.

In summary, it is reasonable to believe that emotional thinking reflects the neurological, psychological and social basis of human emotions in realistic thinking, and that it is an ideal type of thinking that includes emotional factors.

6. Emotional computing based on the simulation of emotional thinking is the foundation of AI

6.1 Emotional computing is essentially a process of deduction mixed with emotions and a simulation of human emotional thinking

The first person to propose the concept of ‘affective computing’ (emotional computing) was Rosalind W Picard of the MIT Media Lab. In her 1997 book Affective Computing, Picard introduced the term ‘affective computing’ for all computations related to emotions, caused by emotions or intentionally affecting emotions (Xu, 2008: 8). The concept
focuses on the external manifestations of human emotions, especially computations that can be measured and analysed and that affect people’s emotions. The application of affective computing in AI aims to create a machine system that can sense, recognize and understand human emotions and make the corresponding intelligent reactions. Truly intelligent computers that are able to communicate and interact normally with humans must have the ability to recognize and express emotions because emotions are essentially a more fundamental and deeper form of cognition. This can be seen as a key element of AI. Emotional computing is, in essence, a simulated process of deduction mixed with emotions. Its end goal is to simulate human emotional thinking and enable machines to make similarly instant decisions. In the past, AI mostly referred to technologies that allow us to imitate, extend or enhance human intelligence with artificial methods, whereas the introduction of emotional intelligence will take AI into a new stage. Having completed the five earlier stages of arithmetic computing, mathematical operations, logical deduction, expert systems and pattern recognition, we will soon enter a new stage of emotional computing (Liu, 2014: 8). Deduction mixed with emotions also better captures the specificity of human intelligence.

That said, there are still some qualitative differences between human emotions and machine representations. A person has emotions, whether they express them or not, but computers are different. They express themselves according to programs: There can be a smiling face on the screen, a warm greeting voice or a robotic hug, but all of them are just instructions given by the program when certain conditions are triggered. They are essentially plausible reasoning based on emotional computing. No matter how warm the greeting seems to be, it is a purely behavioural symbol and has no substance or purpose. However, from the perspective of information theory and the principle of economic interaction, no matter whether the objects have any real emotional content, in the eyes of the viewers, these objects all have the ability and channels to express emotions like humans and satisfy their emotional needs. Then, at least according to Turing’s standard, a robot that can mimic human expressions and respond should be regarded as having emotions and intelligence.

6.2 The function of emotional computing is to facilitate the transformation from functional to creative AI

People often assume that it is impossible for a computer to understand human emotions. No matter how heartfelt a confession or how explosive a piece of news may be, none of it makes any sense or difference to the computer. The only thing that the computer does is to convert the information into a string of binary code composed of 0s and 1s for processing, and that processing operation is also conducted according to the intention of the software designer. The computer is present only as a tool. For example, calculators for mathematical operations and notepads for schedule recording and reminders are all just aids to human functions.

AI based on emotional computing, however, is fundamentally different because, like consciousness, it is creativity and flexibility, not computability, that are the most important features of thinking. Thinking is not only about computing but also about making decisions based on the full judgement and analysis of the complex situation around oneself. The reason Google’s AlphaGo could beat Lee Se-dol is not only because Lee as a human made bigger mistakes but also because AlphaGo is driven by the Deep Mind engine, which has a learning ability underpinned by the Monte Carlo tree search algorithm. The core secret is that it has developed a certain ability to recognize and analyse human behaviour and thus acquired a kind of ability to learn and make judgements similar to imagination. This is why it has displayed learning abilities similar to human thinking. This also means that, for the first time, AI has gained creativity, thus achieving a qualitative change from the functional to the creative.

6.3 The economic efficiency of emotional computing is an important growth pole of human society in the future

Emotional computing represents both qualitative progress and a leap forward for AI. Horizontally, it has enabled AI to cover the emotional factors in the thinking process; vertically, it has realized the simulation of the real human thinking process for the first time. All this gives computers a certain
ability to recognize and simulate human emotional thinking and give more appropriate feedback.

In the past, our expectations of the functions of intelligent devices were mostly concerned with mechanical operations, such as intelligent sweeping robots and intelligent shopping mall guidance systems. All of those were developed to take over certain operations or functions from humans. Intelligent systems with emotion-recognition capabilities, however, now have the opportunity to serve the more advanced emotional needs of humans and, instead of just being a usable artefact, to become important members of the future digital home. Given the growing number of ‘empty nesters’ caused by the rapid ageing of China’s population, machines with a certain degree of emotional intelligence will have promising market prospects, which also meets the requirements of our new economic practices, which are aimed at promoting a leap forward of industries from the middle-to-lower end of the value chain to the middle-to-higher end and improving the intrinsic quality of the economy and the competitiveness of all industries.

Technology-wise, for many tasks, especially complex and delicate activities, it is not realistic to replace humans with robots on a large scale in a short period of time, and the socio-economic impact, especially on employment, needs to be carefully considered. However, from the perspective of emotional communication, there is a great deal that robots can do. The immense popularity of social networking platforms proves the desire for communication by individuals who are surrounded by industrialized information, and all the major internet giants are doing their best to develop social communication platforms with greater intelligence. Through the ubiquitous internet, the free connection of every person and any node of the network will eventually be realized, and all people on the planet will be covered by that giant web. Perhaps, by then, the ‘global brain’ will become a reality. This will not only change the cognitive state of human beings but also have a far-reaching impact on the survival and socio-economic structure of the human race.

7. Conclusion
The traditional view of the dichotomy between emotion and thinking is no longer appropriate. Based on the latest breakthroughs in cognitive science, the existence of emotional thinking can be demonstrated on three levels: brain and neurology; human psychology; and social practice. The emotional factor should be formally included in AI research, and emotional thinking should be proposed as an ideal type of human thinking. Emotional thinking generates emotional resources by combining different emotional experiences and then merging them with other information and resources, including physical resources, intellectual resources, psychological resources and social resources, to construct the distinctive cognitive pattern and content of different persons. It is a coherent theory with emotional thinking as its basis. The value of emotional thinking lies in the fact that it not only helps us reach our goals but, more importantly, helps us decide exactly what goals to pursue. Like other forms of thinking, emotional thinking also helps us better survive and thrive in this rapidly changing world.

Some people insist that computers will never have emotions because they cannot have the same subjective feelings as humans and thus cannot develop consciousness and thought. Paradoxically, many rationalists who claim that computers will never have consciousness make their judgements largely based on intuition rather than thorough argumentation. Whether it is John Searle’s Chinese room argument or David Chalmers’s zombie argument, such thought experiments are purely conceptual and lack experimental evidence. What makes the study of thinking in cognitive science more vibrant than traditional epistemological research is that it relies more on cognitive science experiments rather than linguistic analysis and mere speculative argumentation. The debate about thinking and consciousness has been going on for over 2000 years, but is still without a definite conclusion. One of the contributions of cognitive science is that it has introduced a new way of study: Instead of arguing about what thinking and consciousness are, we should try to build a machine with consciousness and the ability to think. No matter whether it succeeds or fails, it will enable us to better understand human intelligence and, more importantly, give a boost to the development of true AI consciousness.

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