1-2020

A review of emotion sensing: Categorization models and algorithms

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Citation

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Abstract

Sentiment analysis consists in the identification of the sentiment polarity associated with a target object, such as a book, a movie or a phone. Sentiments reflect feelings and attitudes, while emotions provide a finer characterization of the sentiments involved. With the huge number of comments generated daily on the Internet, besides sentiment analysis, emotion identification has drawn keen interest from different researchers, businessmen and politicians for polling public opinions and attitudes. This paper reviews and discusses existing emotion categorization models for emotion analysis and proposes methods that enhance existing emotion research. We carried out emotion analysis by inviting experts from different research areas to produce comprehensive results. More-over, a computational emotion sensing model is proposed, and future improvements are discussed in this paper.

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1 Introduction

With the advent of Web 2.0, an increasing number of users is willing to share their comments or experiences on social media [1]. This provides significant opportunities for those who are eager to gauge public opinion or consumer's attitudes toward their services, products or other issues they care about. Sentiment analysis is a research area that aims to detect sentiment polarity from text, audio or video [2]. Sentiment polarity can be positive, such as '*What a nice game this phone has! I enjoy it so much!*'; negative, such as '*I am feeling blue about this brand, angry about it since it cannot power on again*'; neutral, such as '*There is an iPhoneX on his table*'; and mixed or ambivalent, such as '*I feel not well and very tired today, but I am very happy about the new results*'.

Compared to sentiment analysis, emotion sensing yields emotion identification results [3, 4]. It drills deeper to reveal the exact emotions in negative or positive sentiments and recognizes the exact emotions expressed within text. For example, the above text '*I am feeling blue about this brand, angry about it since it cannot power on again*' not only expresses a negative sentiment, it also expresses the "anger" emotion towards "this brand".

Nowadays, emotion sensing has attracted not only increasing interest from researchers but also attention from the industry and the public. Customer-centric needs and values are a key issue for businessmen. Emotion sensing can produce deeper insights to better understand and enhance business models. For example, sadness toward a company's policy represents the feeling of being disadvantaged, loss and disappointment, while anger is a strong feeling of dissatisfaction, annoyance, displeasure, or hostility. Knowing the detailed emotions of customers can facilitate a targeted response to handle a complaint well and it may turn crises into opportunities.

Business corporations are eager to understand their customers as well as competitors better in order to improve their market share. Consumers would like to make better purchase decisions by leveraging online review analysis. Similarly, politicians would like to know the public response timely and accurately to make better decisions through social media analysis. Emotion sensing allows them to poll public opinion and to know relevant emotions as well as attitudes in an efficient and accurate manner.

Currently, most emotion sensing techniques fall into three main groups. The first leverages commonsense knowledge by associating events and objects with specific emotions via a "commonsense dictionary". For example, '*amusement park*' is often associated with enjoyment and '*accident*' is often associated with sadness. The second leverages an emotion ontology to parse the text, scan for key indicator words and derive the overall emotions based on syntax and semantics. The third addresses the problem from a psychology perspective, in which the analysis of the necessary elements that arouse each emotion is performed first and then an algorithm is used to recognize match these elements in text. Whatever emotion sensing methodology is used, having a proper categorization model for emotions is always very important. An emotion sensing method may give erroneous results if the knowledge used is not consistent with a proper emotion model.

In this paper, we review emotion research from the view of psychologists as well as perspectives from social science, computing science, and engineering. After analyzing existing emotion theories and models, we conduct emotion analysis by inviting experts from different research areas to produce more comprehensive and useful results. Based on our literature review, we found that "emotion" has been studied by psychologists, computing scientists and other domain researchers. Therefore, we selected PhD-level knowledgeable experts, which

include the experts who are from computer science, but have research experience working with psychologists.

The rest of the paper is organized as follows: Section 2 discusses the existing emotion research; Section 3 conducts deeper analyses on the existing emotion models and further discusses emotion sensing through experimental analyses; Section 4 discusses the applications of several emotion models; finally, Section 5 concludes the paper by suggesting potential improvements in future investigations.

2 Review of existing emotion models

The research on emotions has a long evolutionary history and emotion research activities have increased significantly over the past two decades. One of the earlier efforts in developing emotion models was the effort of Shaver et al. [5]. They grouped emotions into prototypes on the assumption that different parts of emotion knowledge tend to make up an organized whole [5]. In their experiment, they first selected a group of words and had them rated based on whether the word was an emotion word. This step resulted in 135 emotion words. They then had these words annotated based on their similarity and the words were grouped into categories so that inter-category similarity was minimized but intra-category similarity maximized. Using the typical prototyping approach, they managed to develop an abstract-to-concrete emotion hierarchy and discovered six emotions on the hierarchy's lowest level: *joy, love, surprise, sadness, anger,* and *fear.*

This emotion study implies that most emotions are fuzzy or indistinct and they are combinations of these six basic emotions, which cannot be furthered divided. In this emotion model, Shaver et al. described a tree-structured list of emotions which were also featured by Parrott [6] (see Appendix 1, Table 7).

However, the psychologists Ortony and Turner argued against the view that basic emotions are psychologically primitive [7]. They proposed that all emotions are discrete, independent, and related to each other through a hierarchical structure (see Appendix 2, Fig. 3), hence there is no basic set of emotions that serve as the constituents of others.

Having refuted the existence of basic emotions, Ortony, Clore, and Collins introduced their own emotion model (termed OCC from the initials of the three authors) [8]. In their model, relevant emotions are grouped together based on the strengths of their arousal. The OCC model classifies emotions into 22 emotion types (see Appendix 2, Fig. 3). The hierarchy contains three branches, namely consequences of events (e.g., pleased or displeased), actions of agents (e.g., approving or disapproving), and aspects of objects (e.g., liking or disliking).

In the OCC model, some branches are combined to form a group of compound emotions. They are the following six kinds of emotion groups and each of them includes several basic emotions: fortune-of-others (happy, resentment, gloating and pity), well-being (joy and distress), attribution (pride, shame, admiration, and reproach), attraction (love and hate), prospect relevance (satisfaction, fear, relief, and disappointment) and well-being/attribution compounds (gratification, remorse, gratitude, and anger). The detailed specifications of each of the 22 emotion types are given this OCC model (see Appendix 2, Fig. 3).

A number of ambiguities of the emotions defined in the OCC model were further identified and discussed by computing scientists Steunebrink and his collaborators [9]. Steunebrink et al. revised the OCC model to consist of more detailed branches that contain 24 emotion categories and subcategories (see Appendix 3, Fig. 4). Compared with the initial OCC model, two basic

emotions, *interest* and *disgust*, were added into the OCC model as an additional specialization of liking/disliking (i.e., besides love/hate), based on the familiarity with the object in question.

Ekman's emotion model is based on the argument that there are distinctive facial expressions. The emotions are treated as discrete, measurable, and physiologically distinct in this model. Each of the emotions is a family of related states and this is consistent with Shaver's model. His research states that there are 6 basic emotions – *anger, fear, disgust, joy, sadness,* and *surprise* [10]. Ghazi et al. also made use of the model proposed by Ekman in a study to automatically distinguish between prior and contextual emotion of words in the context of sentences [11].

Plutchik enhanced Ekman's biologically driven perspective and developed the "wheel of emotions" [12]. He constructed a wheel-like diagram of emotions to visualize the eight basic emotions (see Appendix 4, Fig. 5). Plutchik's model suggests eight primary emotions grouped on a positive vs negative basis: *joy* versus *sadness; anger* versus *fear; trust* versus *disgust;* and *surprise* versus *anticipation* [12, 13], and these are placed on opposite sides of the wheel. In this wheel of emotion model, both basic emotions as well as advanced emotions are covered, and there are a total of 32 emotions (see Appendix 4, Fig. 5). This model states that complex emotions are a composition of several basic emotions (see Appendix 5, Table 8) and the main idea is consistent with Shaver's model. However, some of the basic emotions are different from that of the Shaver's model.

On the other hand, Alena et al. proposed measuring each emotion word into values of nine basic emotions: *Anger, disgust, fear, guilt, interest, joy, sadness, shame,* and *surprise* [14]. Suttles et al., however, opted to use Plutchik's model over Ekman's, as they felt that Ekman's model focuses more on negative emotions [15]. The four sets of basic bipolar emotions (the eight basic bipolar emotions defined by Plutchik) allow emotion classification to be treated as a binary classification problem, unlike in the case of Ekman's model [15]. Yu and Wang also made use of Plutchik's model in their analysis of tweets of US sports fans during the 2014 World Cup [16] .

Moreover, emotion models can be characterized as multi-dimensional models, such as 2-dimensional models (bi-dimension model), 3-dimensional models (tri-dimensional model), and 4-dimensional models. The Valence/Arousal bi-dimensional model has a long history in psychology [17]. It places specific emotion concepts in a circumflex model of core affect defined by two basic dimensions: Arousal, which ranges from high to low, and Valence, which varies from positive to negative.

One of the tri-dimensional emotion models is the Pleasure-Arousal-Dominance (PAD) Emotional State Model [17, 18]. Its three nearly orthogonal dimensions provide a sufficiently comprehensive description of emotional states. In this model, temperament is defined as the average emotional state across a representative sample of life situations. In the PAD Temperament Model [17, 18], P, A, and D temperament scores are used to compute and predict a variety of personality scores (e.g., scores on Anxiety, Depression, Panic, Somatization, Empathy, Affiliation, Achievement, Extroversion, Arousal Seeking, Loneliness, Neuroticism, Suicide Proneness, Binge Eating, Substance Abuse, Emotional Stability, Dependency, Aggressiveness, and Fidgeting).

Another tri-dimensional emotion model is Latinjak cube tri-dimensional model as shown in Fig. 1 [19]. In order to cope with the problem of overlapping emotion concepts in bi-dimensional models, Latinjak proposed to add a third dimension, namely the Time Perspective [19]. Using all three dimensions, it was possible to place 20 specific emotion concepts inside the tri-dimensional model as shown in Fig. 1.
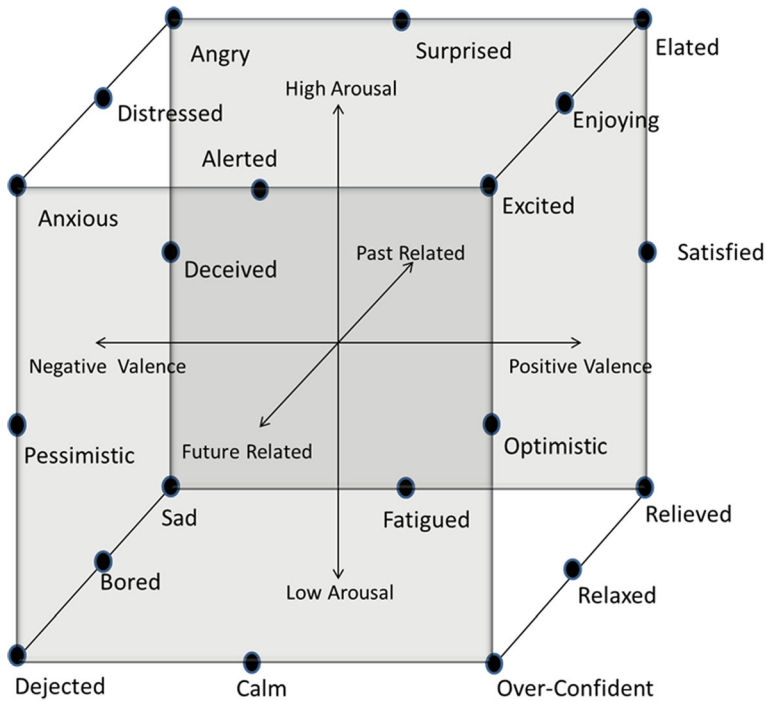
Fig. 1 The specific emotion concepts inside the tri-dimensional model of core affect [19]

This tri-dimensional model is based on former models of core affect that consider two basic dimensions: Arousal and Valence [17]. The difference is that there is a third dimension, namely Time Perspective. Three central levels residing at the center of the 3-dimensional axes are defined in this model: regular arousal, neutral valence, and present perspective. This model hypothesizes that the regular arousal level represents cognitive appraisals, the neutral valence level represents somatic sensations, and the present perspective level represents present-related emotional experiences [19]. Twenty emotion concepts (Fig. 1) are placed inside the model in order to represent the main core affect states which are based on the previous theoretical and empirical publications in the core affect domain and in general sport psychology.

This tri-dimensional model was originally proposed to account for data in the domain of sport psychology. However, the succinct nature of the model not only provides a useful tool for applied sport psychology, it also offers a conceptual framework for research in other domains.

Based on the above emotion models, "The Hourglass of Emotions" model was proposed (Fig. 2), which is a biologically-inspired as well as psychologically-motivated emotion categorization model [20]. In this model, there are four affective dimensions – Sensitivity, Aptitude, Pleasantness, and Attention – each of which is categorized by six sentic levels, which measure the strength of an emotion in the particular dimension, thus giving rise to a set of 24 basic emotions for emotion categorization. Table 1 below displays the six sentic levels under each of the affective dimensions.

This model also takes into account of second-level emotions generated by pairwise combinations of the sentic levels and different concomitant levels of activation producing different kinds of compound emotions (see Appendix 6, Table 9). In addition to the above Valence/Arousal based emotion theories and n-dimension models ($n = 2,3,4$), Robinson, a
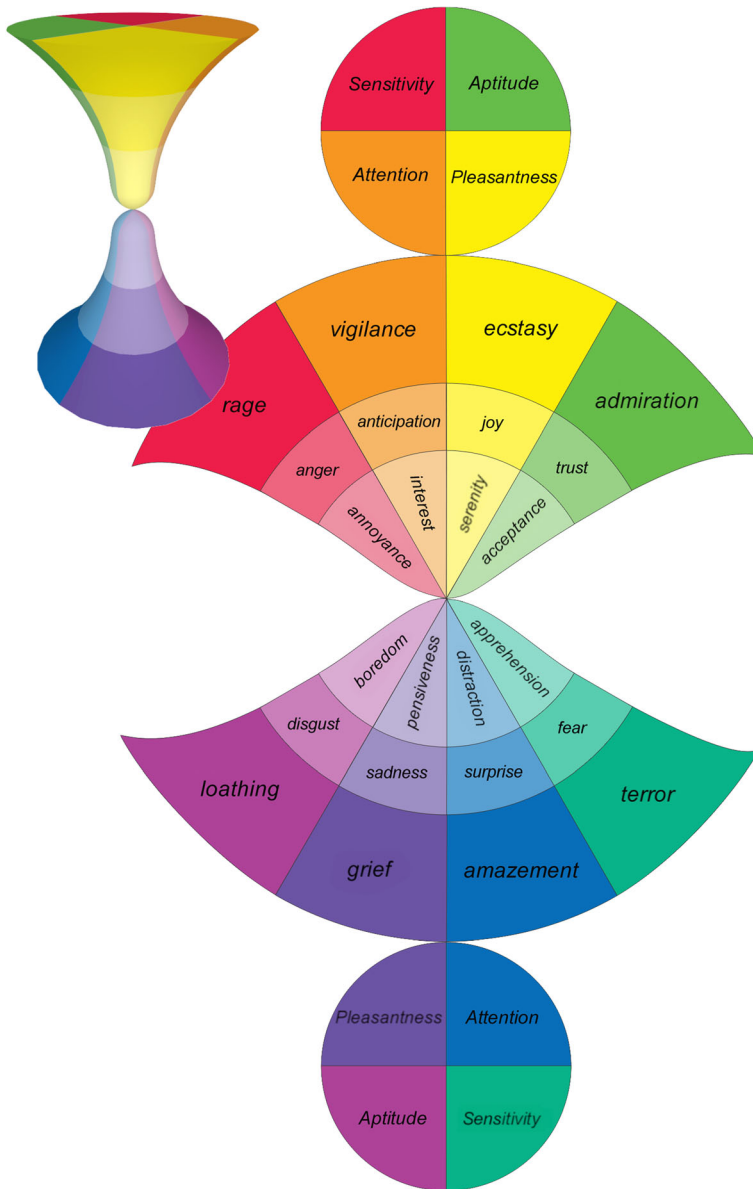
Fig. 2 The Hourglass of Emotions [20]

professor of psychology, proposed that people cannot simply experience some simple and undifferentiated global arousal or activation because there are different ways in which neural and somatic systems can be activated and even different ways in which the thalamocortical system can be activated [21]. Prof. Robinson suggests that certain specific emotional experiences can be considered as basic emotions. According to his emotion theories, there is a clear distinction between 'feelings' and 'emotions' since feelings are mostly related to the state of the body's internal environment. Unlike feelings, emotions are mainly initiated by external

Table 1 Sentic levels of the Hourglass model [20]

Pleasantness	Attention	Sensitivity	Aptitude
Ecstasy	Vigilance	Rage	Admiration
Joy	Anticipation	Anger	Trust
Serenity	Interest	Annoyance	Acceptance
Pensiveness	Distraction	Apprehension	Boredom
Sadness	Surprise	Fear	Disgust
Grief	Amazement	Terror	Loathing

objects or events. Table 2 lists the 11 pairs of positive and negative emotions which were proposed by Robinson as basic emotions [21]. He claimed that any list of basic emotions would seem odd and incomplete if the last four pairs of emotions were not included. He also detailed the causes and consequences of his proposed 11 positive emotions and 11 negative emotions (see Appendices 7 Table 10 and 8 Table 11).

By comparing the different emotion models, we can observe that some of the basic emotions, such as anger and joy, are listed as basic by all researchers, while some of the emotions, such as love and hate, are listed as basic emotions by some researchers such as Robinson [21] but are listed as complex emotions (i.e., compositions of basic emotions) by others (see Appendix 5, Table 8) [12, 13]. Love, for example, is a complex emotion composed of the basic emotions Joy and Trust. Further analysis of different emotion models will be detailed in next section.

3 Further research on existing emotion models with experimental results

3.1 Summary of existing emotion models

According to the above discussion on emotion models, we can see that basically various kinds of emotions have been categorized into different basic emotion groups. Researchers from different research areas have their unique understandings and explanations of the emotion models involved as well as the basic set of emotions defined or used. In total, 65 emotions are

Table 2 Eleven pairs of positive and negative emotions

Kind of emotion	Positive Emotions	Negative Emotions
Emotions Related to Object Properties	Interest curiosity.	Alarm, panic
	Attraction, desire, admiration.	Aversion, disgust, revulsion
	Surprise, amusement.	Indifference, familiarity, habituation
Future Appraisal Emotions	Hope	Fear
Event Related Emotions	Gratitude, thankfulness	Anger, rage
	Joy, elation, triumph, jubilation	Sorrow, grief
	Relief	Frustration, disappointment
Self-Appraisal Emotions	Pride in achievement, self-confidence, sociability	Embarrassment, shame, guilt, remorse
Social Emotions	Generosity	Avarice, greed, miserliness, envy, jealousy
	Sympathy	Cruelty
Cathected Emotions	Love	Hate

defined or discussed in the above emotion models. Table 3 summarizes the above existing emotion models and lists the corresponding basic emotions as well as their associated valence – positive, negative, and neutral. The valence distribution in the table was derived from our experiment with the domain experts.

From Table 3, it is observed that most of the emotions are classified into either having positive or negative valence. For example, anger and sadness are always negative emotions

Table 3 The existing definitions of basic emotions

Author (Year)	Emotion defined	Valence distribution (Number of Positive, Number of Neutral, Number of Negative)	Number of emotions
P. Shaver et al. [5]	• Positive emotions: joy, love, surprise. • • Negative emotions: sadness, anger and fear.	(3,0,3)	6
A. Ortony et al. [8]	• Positive emotions: hope, joy, pride, admiration, love, gratification, gratitude, satisfaction, relief, happy-for, gloating. • Negative emotions: fear, distress, shame, reproach, hate, fears-firmed, disappointment, resentment, pity.	(11,0,11)	22
B. R. Steunebrink et al. [9]	• Positive emotions: hope, joy, pride, admiration, love, gratification, gratitude, satisfaction, relief, happy-for, gloating, interest. • Negative emotions: fear, distress, shame, reproach, hate, fears-firmed, disappointment, resentment, pity, disgust.	(12,0,12)	24
P. Ekman [10]	• Positive emotions: joy, surprise • Negative emotions: sadness, anger, fear, disgust.	(2,0,4)	6
R. Plutchik [13]	• Positive emotions: joy, trust, surprise anticipation. • Negative emotions: sadness, anger, fear disgust	(4,0,4)	8
A. Neviarouskaya et al. [14]	• Positive emotions: interest, joy, and surprise • Negative emotions: anger, disgust, fear, guilt, sadness, shame.	(6,0,3)	9
A. T. Latinjak [19]	Negative emotions: Angry, Distressed, Anxious, Deceived, Pessimistic, Sad, Bored, Dejected, Positive emotions: Elated, Enjoying, Excited, Satisfied, Optimistic, Relieved, Relaxed, Over-Confident Neutral emotions: Alerted, Calm, Surprise, Fatigued	(8,4,8)	20
D. L. Robinson [21]	Positive emotions: Interest, Attraction, Surprise, Love, Gratitude, Joy, Relief, Hope, Satisfaction, Pride, Generosity, Sympathy. Negative emotions: Alarm, Aversion, Indifference, Hate, Anger, Sadness, Frustration, Fear, Dissatisfaction, Embarrassment, Avarice, Cruelty	(11,0,11)	22
E. Cambria [20]	24 emotions as shown in Table 1	(12,0,12)	24

and joy and happiness are always positive emotions. However, some emotions, such as surprise, cannot be simply classified into having a positive or negative valence even though some researchers classified the surprise emotion as a positive emotion. We assume that surprise can have any valence; that is, it can be neutral/moderate, positive (such as pleasant), or negative (such as unpleasant), depending on the context. Surprise can also occur in varying levels of intensity ranging from very-surprised, which may induce the fight-or-flight response, or little-surprised that elicits a less intense response to the stimuli. Some examples indicating surprise can be of any valence are shown in Table 4.

One model that is consistent with the above classification of the surprise emotion is Latinjak's model [17]. Latinjak's model is a tri-dimensional model structured in the form of a cube. In this cubic model, Latinjak defined 20 emotions consisting of 4 neutral emotions: *Alerted, Calm, Surprise,* and *Fatigued* [19]. Even though the surprise emotion is relatively complex as shown in Table 4, Latinjak's classification of surprise as a neutral emotion is an improvement over other previous researchers' work, in which surprise was often classified as a positive emotion. Other authors who mentioned the neutral emotion are Schulz et al. [22]. Inspired by Ekman's emotion model of 6 basic emotions [10], Schulz added the neutral emotion and proposed to classify emotions into 7 classes: anger, fear, disgust, joy, sadness, surprise, and neutral. However, he did not give any specific definition for the neutral emotion. According to Table 4, surprise can be identified as a specific emotion; we assign a "neutral" valence to it since it can have any valence: positive, negative and neutral according to different situations in which the emotion occurs.

3.2 Experiment analysis and discussion

The 65 emotions discussed in the above emotion models are listed in Table 5. In the various research works we surveyed above, there was no mention of the valences (positive, negative, or neutral) of some of the emotions. We hence conducted our own experiment in the form of a survey to determine the valences of these emotions as well as to further ascertain the valences of all the other emotions that were given valences by these earlier research works. We invited 10 expert annotators to independently manually classify the 65 emotions into three valences: positive, negative and neutral (as mentioned above, these experts are from the various fields of computer science, psychology, etc.). The survey results are shown in Table 6. A confusion matrix is incorporated in the table to represent the results. The values correspond to the number of responses given for each of the valence types, such as Positive, Negative, and Neutral, are shown in the table. The valence distributions of these values are also shown in the table.

It is observed that most of the emotions have been classified to be exactly positive (10, 0, 0) or negative (0, 0, 10) valence by all the expert annotators. However, there are indeed some emotions that were classified into positive valence by some of the annotators and into other valences by some other annotators, such as calm (5, 5, 0). (5, 5, 0) means that 5 annotators classified it into positive and 5 annotators classified it into neutral, and no annotators classified it into negative valence. Moreover, for some emotions such as "fatigued", our experimental

Table 4 Examples of the surprise emotion with different valences

Positive	It is really a surprise that I get that gift and I am so happy.
Negative	I am really surprised that she gives gifts to other people rather than me. I am a little bit disappointed
Neutral	When he suddenly came out from such a small box, everyone was surprised.

Table 5 The 65 emotions listed in alphabetic order

Acceptance	Attraction	Distress	Generosity	Interest	Rage	Surprise
Admiration	Aversion	Ecstasy	Gloating	Joy	Relax	Sympathy
Alarm	Boredom	Elated	Gratification	Loathing	Relief	Terror
Alerted	Calmness	Embarrassment	Gratitude	Love	Remorse	Trust
Amazement	Cruelty	Enjoying	Grief	Optimistic	Reproach	Vigilance
Anger	Deceived	Excitement	Guilty	Over-Confident	Resentment	
Annoyance	Dejected	Fatigued	Happy-for	Pensiveness	Sadness	
Anticipation	Disappointment	Fear	Hate	Pessimistic	Satisfaction	
Anxiety	Disgust	Fears-confirmed	Hope	Pity	Serenity	
Apprehension	Distraction	Frustration	Indifference	Pride	Shame	

Emotion classification survey method: some emotions are always negative (e.g., anger), while some are always positive (e.g., joy). However, some emotions may not be able to be simply classified into having positive or negative valence - it can have any valence; that is, it can be neutral/moderate, positive (such as pleasant), or negative (such as unpleasant). In such situation, we select the Neutral valence. This "Neutral" valence means that it can have any valence: positive, negative and neutral according to different situations

results show a valence different from that of the existing model proposed by Latinjak [19]. Another discrepancy is for the emotion "gloating": only 2 out of the 10 experts rated this emotion as positive, which is consistent with that in the literature, e.g., Ortony et al. [8] and Steunebrink et al. [9]. However, most of the experts (8 out of 10) rated this emotion as negative. This is because these experts were rating their own emotions toward someone exhibiting the gloating state. This is negative as someone gloating over others' misfortune is not a pleasant situation.

The detailed specifications of these emotions are also given in Appendix 9 (Table 12) in which we extended the number of emotion categories to 65 emotions based on the above reviewed literature. One of the issues of existing emotion models is that some emotions are differently defined by different researchers. This paper performs further research and study to explain the differences. In the table, we provide brief explanations for the experimental results, especially for those results that show inconsistent valence classification. For example, for the emotion "Over-Confident", there is a disagreement between the experts' rating and that of the literature [19]. Latiniak thinks that this emotion connotes optimism, calm, and relaxation, which are positive states. The experts in this experiment think that being confident is positive but being over-confident has negative consequences, therefore it is negative.

4 Sensing technology by leveraging the existing emotion models

Each of the above emotion models has its own unique characteristics and they have been leveraged or enhanced in different research areas such as social science [23, 24], engineering [25, 26], psychology [27], and computing science [28]. Research on emotion is an important component of behavior analysis. The vigorous quest to identify the effects of emotion on judgment and decision-making is in progress, even though research in this context has a much shorter history [23, 24].

With the help of the OCC emotion model, Li et al. relied on the commonsense knowledge base ConceptNet to extract consequences, agents, and objects from the given text [25]. Moreover, before the OCC rule application, they incorporated the author's personality for consideration. Each author was given a five-element tuple to measure their five-factor personality: openness, conscientiousness,

Table 6 The emotion type specifications of the 65 emotions and our experimental results

No	Emotions	Annotated Results			Normalized Distributions/ Results of Confusion Matrix	Valence in Literature	Valence obtained in our research and the explanations on the results
		Positive	Neutral	Negative			
1	Acceptance	9	1	0	{0.9,0.1,0}	positive	positive	There is agreement among experts and reviewed literature.
2	Admiration	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
3	Alarm	0	4	6	{0,0.4,0.6}	negative	negative	There is partial agreement of the experts' rating with that of the reviewed literature. Some experts feel that the emotion is neutral because such emotion can be perceived as simply something that informs you to take certain actions to address the issues in the situation.
4	Alerted	0	8	2	{0,0.8,0.2}	neutral	neutral	There is reasonable agreement among experts and reviewed literature.
5	Amazement	9	1	0	{0.9,0.1,0}	positive	positive	There is agreement among experts and reviewed literature.
6	Anger	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
7	Annoyance	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
8	Anticipation	4	6	0	{0.4,0.6,0}	postive	neutral	There is partial agreement of the expert's rating with that of the reviewed literature. Some experts feel that the emotion is neutral, because anticipation may not contain any positive or negative consequence.
9	Anxiety	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
10	Apprehension	2	1	7	{0.2,0.1,0.7}	negative	negative	There is partial agreement of the expert's rating with that of the reviewed literature. Some experts feel that the emotion is neutral or positive; apprehension could mean a better preparation for negative consequence.
11	Attraction	9	1	0	{0.9,0.1,0}	positive	positive	There is agreement among experts and reviewed literature.
12	Aversion	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
13	Boredom	0	2	8	{0,0.2,0.8}	negative	negative	There is reasonable agreement of the expert's rating with that of the reviewed literature.
14	Calmness	5	5	0	{0.5,0.5,0}	neutral	neutral	There is partial agreement of the experts' rating with that of the reviewed literature. Some experts feel that the emotion is positive because it is a good quality to be calm.
15	Cruelty	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
16	Deceived	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
17	Dejected	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
18	Disappointment	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
19	Disgust	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.

Table 6 (continued)

No	Emotions	Annotated Results			Normalized Distributions/ Results of Confusion Matrix	Valence in Literature	Valence obtained in our research and the explanations on the results
		Positive	Neutral	Negative			
20	Distraction	0	3	7	{0,0.3,0.7}	negative	negative	There is partial agreement of the experts' rating with that of the reviewed literature. Some experts feel that the emotion is neutral. Their explanation is that such emotion is too weak to be a negative emotion.
21	Distress	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
22	Ecstasy	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
23	Elated	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
24	Embarrassment	0	1	9	{0,0.1,0.9}	negative	negative	There is agreement among experts and reviewed literature.
25	Enjoying	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
26	Excitement	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
27	Fatigued	0	1	9	{0,0.1,0.9}	neutral	negative	There is a disagreement between the experts' rating and that of the literature (Latinjak (2012) [17]. The experts rate this emotion as negative while Latniak rates it as neutral. Latniak (2012) states that fatigue is a somatic sensation and is pre-emotion, therefore he considers this as neutral. While the experts rate this based on the fact that being fatigued is negative.
28	Fear	0	1	9	{0,0.1,0.9}	negative	negative	There is agreement among experts and reviewed literature.
29	Fears-confirmed	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
30	Frustration	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
31	Generosity	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
32	Gloating	2	0	8	{0.2,0,0.8}	positive	negative	There is a disagreement between the experts' rating and that of the literature (e.g. OCC model). The experts rate this emotion as negative while OCC model rates it as a pleasurable state. The experts rate this based on it being an emotion which is negative towards the target issues.
33	Gratification	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
34	Gratitude	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
35	Grief	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
36	Guilty	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
37	Happy-for	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
38	Hate	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.

Table 6 (continued)

No	Confusion Matrix	Annotated Results			Normalized Distributions/ Results of Confusion Matrix	Valence in Literature	Valence obtained in our research and the explanations on the results
	Emotions	Positive	Neutral	Negative			
39	Hope	8	2	0	{0.8,0.2,0}	positive	positive	There is reasonable agreement of the expert's rating with that of the reviewed literature.
40	Indifference	0	3	7	{0,0.3,0.7}	negative	negative	There is partial agreement of the expert's rating with that of the reviewed literature. Most of the experts (7 out of 10) rate it as negative. Some experts feel that the emotion is neutral because indifference connotes irrelevance, which is neutral.
41	Interest	8	2	0	{0.8,0.2,0}	positive	positive	There is reasonable agreement among experts and reviewed literature.
42	Joy	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
43	Loathing	0	2	8	{0,0.2,0.8}	negative	negative	There is reasonable agreement among experts and reviewed literature.
44	Love	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
45	Optimistic	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
46	Over-Confident	0	0	10	{0,0,1}	Positive	negative	There is a disagreement between the experts' rating and that of the literature (Latinjak [19]. Latinjak thinks that this emotion connotes optimism, calm, and relaxation, which are positive states. The experts in this experiment think that being confident is positive but being over-confident has negative consequences, therefore it is negative.
47	Pensiveness	1	6	3	{0.1,0.6,0.3}	Not mentioned	neutral	For this emotion some experts feel that it has an apprehension component, therefore they rate it as negative. However, most of them feel that it is a state of brooding which may contain positive or negative emotion content.
48	Pessimistic	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
49	Pity	0	2	8	{0,0.2,0.8}	negative	negative	Being (displeased about) an event is presumed to be undesirable for someone else
50	Pride	9	1	0	{0.9,0.1,0}	positive	positive	There is agreement among experts and reviewed literature.
51	Rage	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
52	Relax	8	2	0	{0.8,0.2,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
53	Relief	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
54	Remorse	2	0	8	{0.2,0,0.8}	negative	negative	There is perfect agreement among experts and reviewed literature.
55	Reproach	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
56	Resentment	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.

Table 6 (continued)

No	Emotions	Annotated Results			Normalized Distributions/ Results of Confusion Matrix	Valence in Literature	Valence obtained in our research and the explanations on the results
		Positive	Neutral	Negative			
57	Sadness	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
58	Satisfaction	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
59	Serenity	9	1	0	{0.9,0.1,0}	Not mentioned	positive	According to the results, 1 out of 10 experts rate this emotion as neutral, because they think that being in a state of serenity does not imply any particular sentiment. However, most of the experts (9 out of 10) who rate this as positive are thinking that being in a state of serenity means calm and peaceful, hence being in such emotion is a good state.
60	Shame	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
61	Surprise	2	8	0	{0.2,0.8,0}	positive in [2] [4, 9, 12] [19]. neutral in [17]	neutral	There is partial agreement of the experts' rating with that of the reviewed literature. However, in most literature, this emotion is deemed positive while most experts rate it as neutral. We believe the neutral valence is a better characterization of the emotion because one can be surprised about a negative situation. (In our classification survey rules, if an emotion can represent a positive as well as a negative feeling or sentiment depending on the situation, a neutral valence will be assigned).Therefore, in this paper, we claim that surprise has a neutral valence.
62	Sympathy	5	5	0	{0.5,0.5,0}	positive	positive	There is partial agreement of the expert's rating with that of the reviewed literature. Some experts feel that the emotion is neutral because even though the recipient of the sympathy is in a negative situation, the sympathizer's emotional state does not contain positive or negative contents.
63	Terror	0	0	10	{0,0,1}	negative	negative	There is perfect agreement among experts and reviewed literature.
64	Trust	10	0	0	{1,0,0}	positive	positive	There is perfect agreement among experts and reviewed literature.
65	Vigilance	2	8	0	{0.2,0.8,0}	Not mentioned	neutral	According to the results, 2 out of 10 experts rate this emotion as positive, because they think that vigilant is a good state to be in. However, for experts who rate this as neutral, they are thinking that being in a state of vigilance does not imply any particular sentiment per se, but is merely a preparatory state for future consequences.

agreeableness, extraversion, and neuroticism. The result from emotion categorization may be calibrated based on these tuple values. For example, an extravert might experience joy during the event of a conversation whereas an introvert might not.

Huangfu et al. also used the above mentioned OCC model for emotion identification [26]. They proposed measuring each word in the dictionary with a value in two dimensions: desirability and worthiness. Given some seed words with prescribed values on the two dimensions, they relied on the word's antonym and synonym relationship to repeatedly calculate the other words' values on both dimensions. For ambiguous words, they used calculated subjective polarity to resolve conflicts. As soon as the emotion-dimension dictionary was built, they scanned each input text to calculate its overall value for both dimensions and derived the emotion category based on the six rules proposed in the OCC model.

Soares et al. proposed an approach for determining the affective norms for English words (ANEW) by leveraging the PAD model for assigning normative emotional ratings to text [27]. Shivhare et al. adopted the hierarchical emotional model of Shaver et al. and developed their own computational model [28]. In this model, first an emotion word hierarchy is constructed using Protégé, a free, open source ontology editor. Then, given any input text, the algorithm traverses the ontological hierarchy and attempts to detect any emotion word in the input text. Once a word is identified in a sentence, its score is calculated which is inversely proportional to the word's depth in the hierarchy and proportional to its frequency of appearance. After the traversal, the score of each word in the child nodes is summed towards the parent node from the bottom to the top. Hence, at the top six emotion nodes—joy, love, surprise, sadness, anger, and fear—six values are derived. The emotion with the maximum score is chosen as the dominant one in the text.

Based on the Hourglass model, Cambria et al. proposed sentic computing [29], a multi-disciplinary approach that aims to bridge the gap between statistical NLP and many other disciplines that are necessary for understanding human language, such as linguistics, commonsense reasoning, and affective computing. Sentic computing enables the analysis of text not only at document, page or paragraph level, but also at sentence, clause, and concept level. This is possible thanks to an approach to NLP that is both top-down and bottom-up: top-down for the fact that sentic computing leverages symbolic models such as semantic networks [30] and conceptual dependency representations [31] to encode meaning; bottom-up because sentic computing uses sub-symbolic methods such as deep neural networks [32] and multiple kernel learning [33] to infer syntactic patterns from data.

For emotion sensing, rule-based, commonsense-based, and learning-based methods have been implemented [3, 34]. However, the effectiveness of such methods is still a challenge due to the lack of open datasets as benchmarks, the lack of a formal definition about emotion cause events and the small size of corpus for emotion cause identification [3, 35]. Gui et al. constructed a public dataset from SINA city news which considered the clauses up to the previous and next 3 clauses of the emotion instance identified [36]. They adopted Ekman's 6 primary emotions [10], but their work is limited to formal text contents and the definition is based on the language structure of Chinese. Ding et al. proposed an improved method using a new neural architecture which considers 2 additional factors besides text content: relative position and global prediction [37]. Xia et al. further improved on Ding's framework by accounting for relationships between multiple clauses in the text and proposed using RNN Transformer Hierarchical Network (RTHN) to encode and classify multiple clauses simultaneously [38]. In another work by Xia and Ding, an enhanced model was proposed to consider 2 subtasks: emotion extraction and cause extraction. Information from one task can help in

determining the relevant clauses in the other. Both the emotion and its associated cause can be extracted concurrently [39].

There are many other sensing technologies in which the above emotion models are leveraged and enriched [2, 14, 29, 30, 40, 41, 42, 43]. For example, Alena et al. enhanced the model of Shaver, Ekman, and Plutchik and used 9 basic emotions: anger, disgust, fear, guilt, interest, joy, sadness, shame, and surprise [14]. They took the typical lexical approach and had each emotion word annotated by expert annotators and compiled the words into an emotion dictionary. After the sequential steps of word-level, phrase-level, and sentence-level analysis under various handcrafted rules, they derived an overall emotion. Wang et al. developed new sensing methods which had the capabilities to derive dominant sentiment valence as well as basic emotions such as Anger, Sadness, Anxiety, Happiness, and Excitement [40, 41].

From the point of view of implementing emotion sensing technologies, researchers can leverage on the above emotion models and select different sets of emotions to address different problems. Also, more specific emotions such as Inspired, Keen, and Hopeless that are not listed and discussed above in the various emotion models can be added when implementing various emotion sensing technologies to address the requirements of different applications. Sentiment and emotion sensing of text data can be used to address theoretical issues as well as practical problems [42, 43, 44, 45]. Knowing users' emotions and attitudes towards specific topics are always the top requirement for industry, such as predicting consumer preferences.

5 Conclusion and future directions

In this paper, we reviewed and discussed existing emotion models from the perspective of psychology, science, computing and engineering. We analyzed existing emotion definitions and enhanced current emotion theories through further research and experiments. We conducted emotion analysis through designing experiments in which PhD-level experienced experts from different research areas were invited to participate. Various applications of emotion models for performing emotion sensing were analyzed. Then, we explored the idea of shrinking the range of possible emotions based on the predetermined emotion categories and all the 65 emotions are studied and re-defined based on the experiment results. Following this, emotion sensing can be better performed based on the emotion definitions.

Whatever emotion model employed, researchers tend to compute the emotion directly, without the help of any sentiment or tone of the overall sentence. However, sentiment and emotion are closely related. For example, anger and sadness emotions are always negative sentiments and will never be positive. Therefore, associating emotions with sentiments is a promising research direction and it is also part of our ongoing work.

Another important aspect is the real-world applications of emotion theories and models. Different emotion categories are required for different users. For example, public figures such as politicians and actors may care about whether the public accept them or trust them, so the love and trust emotions should be considered in the emotion sensing tools, while for companies, customer satisfaction is always the most important issue. Also, currently available sensing tools mainly focus on aggregate level analysis (positive or negative), but the industry may need emotion sensing tools to drill deeper and reveal the exact emotions in the sentiments - such as anger and sadness associated with negative sentiment. Another important aspect concerns next-generation AI. Emotions expressed by human beings are part of high-level human behavior. Therefore, incorporating the understanding of emotions into an intelligent agent is key exhibit human-like behavior.
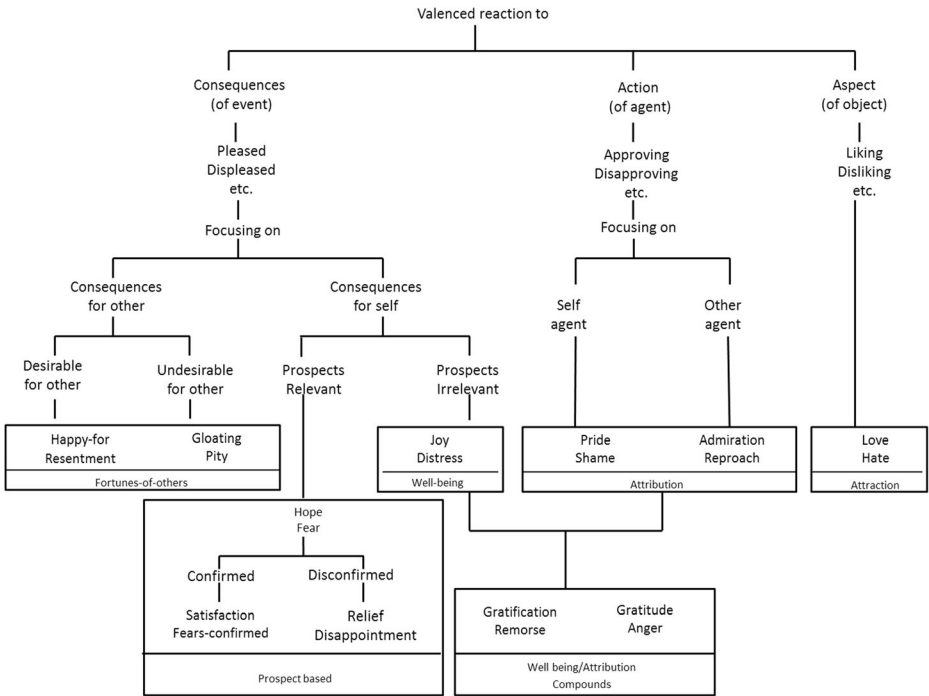
Appendix 1

Fig. 3 The structure of emotions of the OCC Model [8]
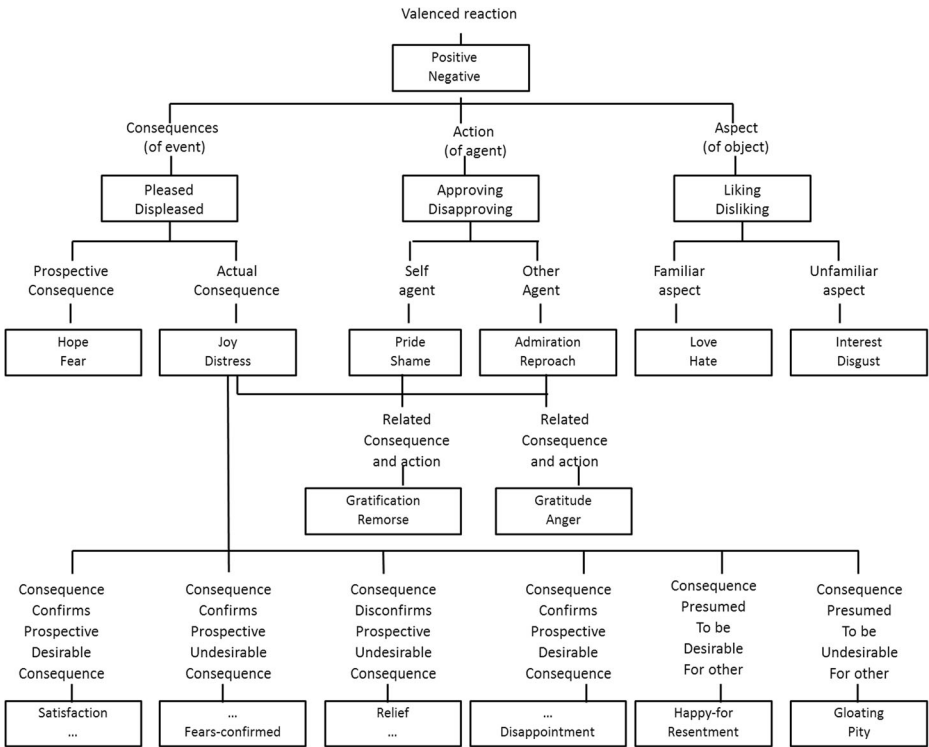
Appendix 2

Fig. 4 A disambiguated, inheritance-based hierarchy of emotions of the OCC Model (Revised OCC Model)

Appendix 3

Table 7 A tree-structured list of emotions described in Shaver model and also featured by Parrott [5, 6]

| No.	Primary emotion	Secondary emotion	Tertiary emotion
1	Love	Affection	Adoration · Fondness · Liking · Attractiveness · Caring · Tenderness · Compassion · Sentimentality
		Lust/Sexual desire	Desire · Passion · Infatuation
		Longing	Longing
2	Joy	Cheerfulness	Amusement · Bliss · Gaiety · Glee · Jolliness · Joviality · Joy · Delight · Enjoyment · Gladness · Happiness · Jubilation · Elation ·Satisfaction · Ecstasy · Euphoria
		Zest	Enthusiasm · Zeal · Excitement · Thrill · Exhilaration
		Contentment	Pleasure
		Pride	Triumph
		Optimism	Eagerness · Hope
		Triumph	Triumph
		Enthrallment	Enthrallment · Rapture
		Relief	Relief
3	Surprise	Surprise	Amazement · Astonishment
4	Anger	Irritability	Aggravation · Agitation · Annoyance · Grouchy · Grumpy · Crosspatch
		Exasperation	Frustration
		Rage	Anger · Outrage · Fury · Wrath · Hostility · Ferocity · Bitter · Hatred · Scorn · Spite · Vengefulness · Dislike · Resentment
		Disgust	Revulsion · Contempt · Loathing
		Envy	Jealousy
		Torment	Torment
5	Sadness	Suffering	Agony · Anguish · Hurt
		Sadness	Depression · Despair · Gloom · Glumness · Unhappy · Grief · Sorrow · Woe · Misery · Melancholy
		Disappointment	Dismay · Displeasure
		Shame	Guilt · Regret · Remorse
		Neglect	Alienation · Defeatism · Dejection · Embarrassment · Homesickness · Humiliation · Insecurity · Insult · Isolation · Loneliness · Rejection
		Sympathy	Pity · Mono no aware · Sympathy
6	Fear	Horror	Alarm · Shock · Fear · Fright · Horror · Terror · Panic · Hysteria · Mortification
		Nervousness	Anxiety · Suspense · Uneasiness · Apprehension (fear) · Worry · Distress · Dread

Appendix 4
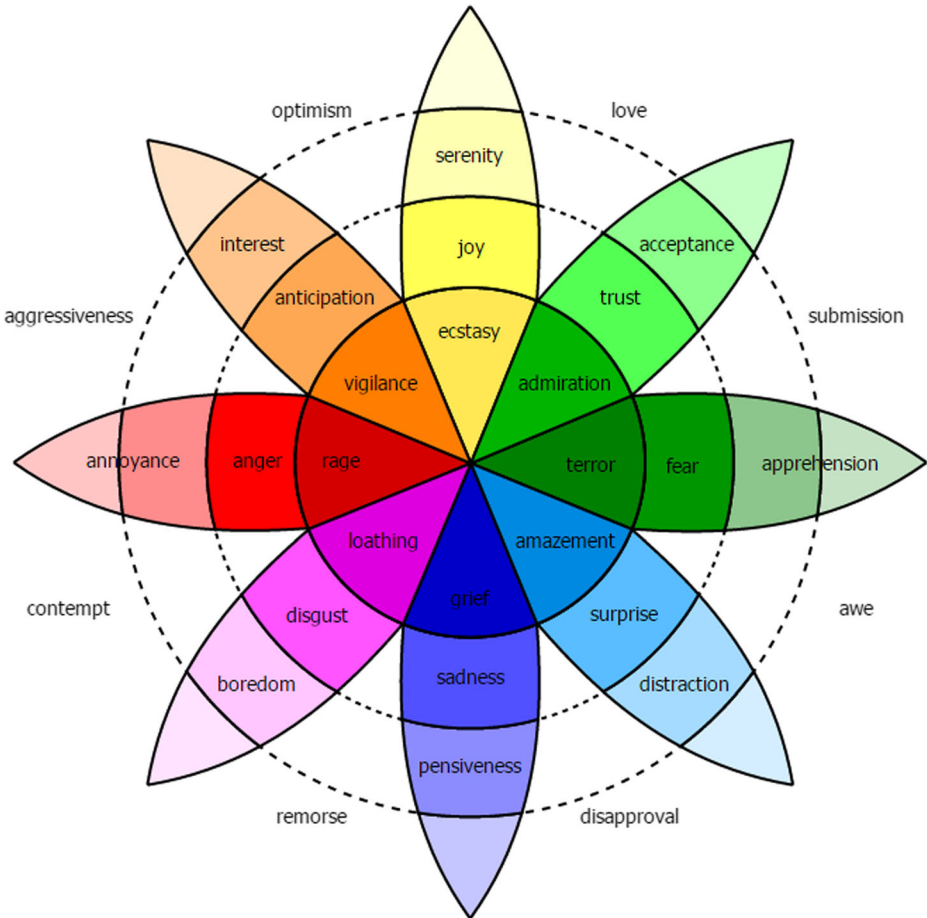
Fig. 5 Plutchik's Wheel of Emotions [12, 13]

Appendix 5

Table 8 Complex Emotions are a composition of basic emotions [12, 13]

Human feelings (results of emotions)	Emotions	Opposite
Optimism	Anticipation + Joy	Disapproval
Love	Joy + Trust	Remorse
Submission	Trust + Fear	Contempt
Awe	Fear + Surprise	Aggression
Disapproval	Surprise + Sadness	Optimism
Remorse	Sadness + Disgust	Love
Contempt	Disgust + Anger	Submission
Aggressiveness	Anger + Anticipation	Awe

Appendix 6

Table 9 Second-level emotions derived from the combinations of different sentic levels of each of the affective dimensions [20]

	Attention >0	Attention <0	Aptitude >0	Aptitude <0
Pleasantness >0	Optimism	Frivolity	Love	Gloat
Pleasantness <0	Frustration	Disapproval	Envy	Remorse
Sensitivity >0	Aggressiveness	Rejection	Rivalry	Contempt
Sensitivity <0	Anxiety	Awe	Submission	Coercion

Appendix 7

Table 10 Eleven positive emotions and their causes and consequences [21]

No	Mental experience	Correlate of the mental experience	Behaviour motivated by mental experience	Putative significance for survival
1	Interest, curiosity	Novel stimulation of moderate or low intensity and no mismatch with expectations.	Orienting reflex, moderate behavioural arousal, exploration	Attracts to new experiences that might aid survival
2	Attraction, desire, admiration	Signals of good environmental conditions, nutritional value and health giving properties and absence of genetic defects indicating good reproductive outcomes	Acceptance of contact. Seeking to establish and maintain contact	Ingestion of healthy food, selection of healthy environments, promotion of reproductive success
3	Surprise, amusement	Mismatch between experience expected and experience that occurs	Attention, laughter or behavioural immobility depending on the degree of mismatch	Stimulates interest but may also induce caution to allow time for cognitive appraisal
4	Hope	Expectation of a positive outcome	Behaviours consistent with a positive outcome	Responding to signals previously associated with positive outcomes
5	Gratitude, thankfulness	Acts of kindness, mercy, assistance and co-operation done by an-other	Reciprocal acts of kindness and assistance	Development of social bonds and friendship
6	Joy, elation, triumph, jubilation	Successful performance of genetically predetermined life sustaining and propagating behaviours but ultimately the moment when hopes are realised and success achieved	Life sustaining and propagating behaviours and the achievement of objectives	Continuation of life sustaining and propagating behaviours and repetition of successful behaviours
7	Relief	Success when failure expected or confirmation that an aversive event will not occur	Cessation of behavioural inhibition	Encourages behaviour that reduces threat
8	Pride in achievement,	Pleasant thoughts that derive from the execution of behaviours that are in	Behaviours consistent with personal belief and ideas about 'right' and 'wrong'.	Rational control of behaviour in a social context

Table 10 (continued)

No	Mental experience	Correlate of the mental experience	Behaviour motivated by mental experience	Putative significance for survival
	self-confidence, sociability	accordance with personal beliefs and values	Behaviours designed to enhance feelings of self-satisfaction	
9	Generosity	Benevolent thoughts about others	Behaviours designed to assist others by sharing possessions	Enhances survival of community
10	Sympathy	The vicarious experiencing of the feelings, thoughts and attitudes of others. Empathy which derives from the intellectual capacity to understand the mental life of others	Kind, compassionate and caring behaviours that help other people	Emotional support of community members and the promotion of social harmony
11	Love	A complex set of emotionally toned ideas that cause strong feelings of affection and attachment to other people and sometimes also to animals, objects and even ideas	Motivates people to cherish each other and sometimes to sacrifice life itself in order to protect what is perceived to be beautiful and good	Form strong and affectionate bonds between people and motivates the altruistic service of society

Appendix 8

Table 11 Eleven negative emotions and their causes and consequences [21]

No	Mental experience	Correlate of the mental experience	Behaviour motivated by mental experience	Putative significance for survival
1	Alarm, terror, panic	Unlearned signals of immediate and extreme danger, such as very intense stimulation	Orienting reflex, defence reflex, strong behavioural arousal, fight, flight	Self preservation
2	Aversion, disgust, reculsion	Signals of bad environmental conditions, contagious toxicity and genetic defects indicating poor reproductive outcomes	Rejection of contact or seeking to avoid contact	Avoidance of life-threatening objects and environments, promotion of reproductive success
3	Indifference, familiarity, habituation	Habituation or inhibition of familiar sources of stimulation that have no significance	None	Blocking attention to sources of stimulation that did not signal pain or pleasure in the past
4	Fear	Expectation of a negative outcome	Behaviours consistent with a negative outcome	Avoiding dangers signalled by prior associative learning
5	Anger, rage	Physical pain inflicted by an attacker or psychological pain caused by thoughts about real or imagined harm done by another	Fight or other forms of aggressive behaviour	Genetically programmed defence or territory. Harm to object, vengeance, retribution
6	Sorrow, grief			

Table 11 (continued)

No	Mental experience	Correlate of the mental experience	Behaviour motivated by mental experience	Putative significance for survival
		The death of a loved one, usually a family member or close friend but may also occur due to the damage or loss of any valued object or relationship	Weeping and other behaviours indicating distress	Indicates the need for emotional support and may have its origin in infant 'separation distress'
7	Frustration, disappoint-ment	Failure when success expected or confirmation that a pleasant event will not occur	Discontinuation of related behaviour	Cessation of unsuccessful behaviours
8	Embarrassment, shame, guilt, remorse	Painful thoughts about real or imagined public failure to meet social standards and/or self-criticism that derives from failure to behave in accordance with personal beliefs and values	Avoiding social contact and public places. Behaviours consistent with personal beliefs and ideas about 'right' and 'wrong'. Behaviours designed to assuage painful thoughts	Rational control of behaviour. Social conformity
9	Avarice, greed, miserliness, envy, jealousy	Resenting another's success. Coveting their possessions or attention they receive. Or guarding and hoarding own possessions	Spiteful and malicious behaviour Selfish behaviour	Rivalry. Seeking personal advantage at the expense of others
10	Cruelty	Sadistic thoughts associated with the desire to hurt others or with gloating over the misfortune of others. Lack of empathy that causes social conflict and alienation	Behaviours designed to avenge real or imagined wrongs and to hurt, torment or torture others into subjugation and submission	Harm to others and subjugation of others through intimidation and punishment. Domination in a social hierarchy
11	Hate	A complex set of emotionally toned ideas that cause strong feelings of hostility and alienation	Motivates people to seek to destroy what is believed to be evil and to risk their lives in a fight against evil	Destruction of what threatens self or communal well being

Appendix 9

Table 12 Emotion type specifications of the 65 emotions which are extended from reviewed literatures by this research

The emotion type specifications of the 65 emotions

No	Emotion Labels	
1	Acceptance	Acceptance means embracing something in all its aspects, and being in complete agreement with something, giving it your full support and approval. Acceptance is sharing, it is actually doing something, taking part and feeling involved with others, looked upon with satisfaction. It is recognising something that is in keeping with your own world, acceptance, be it given or received, is an interior caress that strengthens what we are, and is confirmation not only of the goodness of our form, but also what we do and what we are.
2	Admiration	Admiration is an emotion approving of someone else's praiseworthy action. Admiration is the feeling of appreciating or liking, it is often used to describe an individual when he or she feels delight with regard to somebody or something. It is a passive feeling of contentment.
3	Alarm	An anxious awareness of danger, make (someone) feel frightened, disturbed, or in danger.
4	Alerted	Warn (someone) of a danger or problem.
5	Amazement	Admiration is the feeling of appreciating or liking, it is often used to describe an individual when he or she feels delighted with regard to somebody or something. It is a passive feeling of contentment.
6	Anger	(Disapproving of) someone else's blameworthy action and (being displeased about) the related undesirable event. Anger is a strong feeling of annoyance, displeasure, or hostility. it is a feeling of rebellion, a strong form of defence accompanied by a sense of revenge. Stoked by the feeling of having been wronged, or suffered an injustice that we simply can't accept, anger is often associated with the dark fact of not being able to do something, the feeling of being impotent when faced with things that annoy and offend us without being able to do anything to put things right.
7	Annoyance	The feeling or state of being annoyed; irritation. a thing that annoys someone; a nuisance.
8	Anticipation	Anticipation is an emotion involving pleasure and excitement with regard to a future event. For example a person could be anticipating his participation in a concert with his favourite band.
9	Anxiety	Anxiety is a state of alarm that takes our breath away, anxiety tries us, weakens us and weighs us down. Anxiety is a mixture of fear and expectation, it is a vague, overpowering and gloomy feeling of dread with no clear perception of what is causing it, it is a feeling of something that we worry could happen before long, or a build-up of worries that overwhelm us and which, all of a sudden, we perceive to be greater than what we can handle or cope with. The adjectival form is anxious which means feeling or showing worry, nervousness, or unease about something with an uncertain outcome.
10	Apprehension	Anxiety or fear that something bad or unpleasant will happen. Understanding; grasp.
11	Attraction	The action or power of evoking interest in or liking for someone or something. A quality or feature that evokes interest, liking, or desire.
12	Aversion	A strong dislike or disinclination. Someone or something that arouses a strong dislike or disinclination.
13	Boredom	Boredom is a state of dissatisfaction, a lack of reactivity to external stimuli, caused, in general, by a feeling of emptiness. Boredom creeps up on us silently, we are lifeless, bored and have no interest in anything, due perhaps to a build-up of disappointments, or, just the opposite, due to an excess of stimuli that leads to boredom, taking away our ability to be amazed or startled anymore when things happen.
14	Calmness	Not showing or feeling nervousness, anger, or other strong emotions. The absence of strong emotions.
15	Cruelty	Cruel behaviour or attitudes. Cruelty is indifference to suffering, and even pleasure in inflicting it
16	Deceived	

Table 12 (continued)

The emotion type specifications of the 65 emotions

No	Emotion Labels	
		Sdeliberately cause (someone) to believe something that is not true, especially for personal gain. To mislead by a false appearance or statement
17	Dejected	Dejected is an emotion relevant to sad, depressed or dispirited.
18	Disappointment	Being displeased about the disconfirmation of the prospect of a desirable event
19	Disgust	Disgust is refusal, it is the revulsion and rejection felt for something that does not comply with how we feel or see the world. Refusing something that is completely alien to us, creating a feeling of annoyance or even loathing. Disgust picks out things and people that we come across in our lives, making us instinctively distance ourselves from everything that we don't like, repulses us, irritates us and makes our skin crawl.
20	Distraction	Distraction is a diversion of a person's mental state. The opposite of concentration which is the focus on something or someone, a distracted person has his mind split on different things around him.
21	Distress	(Displeased about) an undesirable event
22	Ecstasy	Ecstasy is a feeling of overpowering happiness, it is a burst of intense positive emotions and it is used to describe someone as being extremely happy at a given point of time.
23	Elated	Make (someone) ecstatically happy. Very happy or proud; jubilant; in high spirits
24	Embarrassment	A feeling of self-consciousness, shame, or awkwardness.
25	Enjoying	Take delight or pleasure in (an activity or occasion).
26	Excitement	Excitement is a state of euphoria and physical activation, which uplifts us and makes us feel full of adrenalin and active. Instilling us with a desire to live as well as enjoy and take delight in things, excitement is enthusiasm for something, for a situation that we are waiting for in trepidation, encouraging us to put ourselves to the test, giving it our best shot. It makes us feel alive, positively projected towards an exteriority that makes us chafe at the bit and want to do things. The adjectival form is excited, which means very enthusiastic and eager.
27	Fatigued	Cause (someone) to feel exhausted. Weaken (a metal or other material) by repeated variations of stress
28	Fear	(Displeased about) the prospect of an undesirable event. Fear is a strong reaction, with decisive physiological connotations, an automatic reaction of defence when faced with danger, but also the unexpected and the unknown. We are frightened by fear, fear blocks us in our tracks and freezes us to the spot, we would like to run away when faced with what causes us to fear, and we don't know how to fight it, nor are we effectively capable of dealing with it.
29	Fears-confirmed	(Displeased about) the confirmation of the prospect of an undesirable event.
30	Frustration	The feeling of being upset or annoyed as a result of being unable to change or achieve something. The prevention of the progress, success, or fulfilment of something.
31	Generosity	The quality of being kind and generous. The quality or fact of being plentiful or large.
32	Gloating	(Pleased about) an event presumed to be undesirable for someone else.
33	Gratification	(Approving of) one's own praiseworthy action and (being pleased about) the related desirable event.
34	Gratitude	(Approving of) someone else's praiseworthy action and (being pleased about) the related desirable event.
35	Grief	Grief is the feeling of something bad we did in the past that keeps coming back with its negative waves to the present. Grief is the dark shadow looming over our conscience caused by past actions, a certain behaviour or words that were said, accompanied by a feeling of heaviness upon realising that any chance of putting things right is now out of our hands. And it grabs us and keeps us in its vice-like grip, making us feel bad and unsatisfied with ourselves.
36	Guilty	Guilt is a cognitive or an emotional experience that occurs when a person believes or realizes—accurately or not—that he or she has compromised his or her own standards of conduct or has violated a moral standard and bears significant responsibility for that violation. It is closely related to the emotion of remorse.
37	Happy-for	(Pleased about) an event presumed to be desirable for someone else. Happy-for emotion is an expression of pleasure at an fleeting moment. It is triggered by events happening

Table 12 (continued)

The emotion type specifications of the 65 emotions

No	Emotion Labels	
		around an individual at any given moment. Each individual responds differently to different triggers and events.
38	Hate	(Disliking) an unappealing object.
39	Hope	(Pleased about) the prospect of a desirable event.
40	Indifference	Lack of interest, concern, or sympathy.
41	Interest	Interest is a form of curiosity for something that keeps out attention span alive. It is a state of emotion that creates a state of suspension and curious expectation, with shades that are also intellectual at times, and it encourages us to want to go further when encountering something that has grabbed our attention, and which, just for a second, has taken up all of our attention.
42	Joy	(Pleased about) a desirable event. Joy is a synonym of happiness, this word is used when a person is in a state of extreme happiness. It can also be said that the emotional state of joy is long-lasting, unlike happiness which lasts briefly for an individual.
43	Loathing	Loathing is an expression of great dislike for something that has offended our way of being. It is a form of rebellion, defence, and contempt that distances something from us and our sphere of values which, in its form and behaviour, offends what we are, what we believe in, and what we pursue.
44	Love	(Liking) an appealing object.
45	Optimistic	Hopeful and confident about the future. (Of an estimate) unrealistically high.
46	Over-Confident	Excessively confident.
47	Pensiveness	A person who is pensive is engaged in deep and serious thought, such a person is in deep contemplation. It can also be used to describe an individual who is thoughtful when reminiscing about past events, which usually is synonymous with sadness.
48	Pessimistic	Pessimism is a state of mind in which one anticipates undesirable outcomes or believes that the evil or hardships in life outweigh the good or luxurious. Value judgments may vary dramatically between individuals, even when judgments of fact are undisputed. The most common example of this phenomenon is the "Is the glass half empty or half full?" situation. The degree in which situations like these are evaluated as something good or something bad can be described in terms of one's optimism or pessimism respectively.
49	Pity	(Displeased about) an event presumed to be undesirable for someone else.
50	Pride	(Approving of) one's own praiseworthy action.
51	Rage	Rage is an emotional state to express extreme anger, rage is different from anger that it can also be violent, causing an individual to lose control and cause physical harm around him.
52	Relax	Free from tension and anxiety. (Of a muscle or other body part) not tense.
53	Relief	(Pleased about) the disconfirmation of the prospect of an undesirable event.
54	Remorse	(Disapproving of) one's own blameworthy action and (being displeased about) the related undesirable event.
55	Reproach	(Disapproving of) someone else's blameworthy action.
56	Resentment	(Displeased about) an event presumed to be desirable for someone else.
57	Sadness	Sadness is a state that we usually associate with happiness as its opposite. We are sad when a certain event makes us unhappy, dampening our enthusiasm and making us feel down. Sadness is a minor tone, bland and melancholic, a general feeling of despondency that makes us tearful.
58	Satisfaction	(Pleased about) the confirmation of the prospect of a desirable event.
59	Serenity	Serenity is peace and a feeling of balance, autonomy and quiet due to a lack of worries that could upset our soul. Satisfaction and rest, serenity infuses a widespread feeling of wellbeing, it is a state of mind that is similar to being relaxed.
60	Shame	(Disapproving of) one's own blameworthy action. Shame is an emotion that is experienced when a person thinks that his dignity and worthiness got lowered somehow. Shame is a painful, social emotion that can be seen as resulting "...from comparison of the self's action with the self's standards...", but which may equally stem from comparison of the self's state of being with the ideal social context's standard.

Table 12 (continued)

The emotion type specifications of the 65 emotions

No	Emotion Labels	
61	Surprise	Surprise is a brief mental and physiological state, a startle response experienced by animals and humans as the result of an unexpected event. Surprise can have any valence; that is, it can be neutral/moderate, pleasant, unpleasant, positive, or negative. Surprise can occur in varying levels of intensity ranging from very-surprised, which may induce the fight-or-flight response, or little-surprise that elicits a less intense response to the stimuli.
62	Sympathy	Feelings of pity and sorrow for someone else's misfortune. Understanding between people; common feeling.
63	Terror	Terror is a very strong feeling of fear, something which is terrifying that strikes fear into the hearts of people.
64	Trust	Trust is the reliance on others or the confident expectation of future events. Trust in people is believing that they will not take advantage of your vulnerability. Trust is based on confidence and an individual's experience of knowing another for a period of time.
65	Vigilance	Vigilance is the state of being wary to your surroundings, this can be caused if an individual is at a place which he is unfamiliar of, or is aware that there is possible danger around him. An individual who is vigilant is much more careful about their surroundings.

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