The Hourglass of Emotions

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Abstract. Human emotions and their modelling are increasingly understood to be a crucial aspect in the development of intelligent systems. Over the past years, in fact, the adoption of psychological models of emotions has become a common trend among researchers and engineers working in the sphere of affective computing. Because of the elusive nature of emotions and the ambiguity of natural language, however, psychologists have developed many different affect models, which often are not suitable for the design of applications in fields such as affective HCI, social data mining, and sentiment analysis. To this end, we propose a novel biologically-inspired and psychologically-motivated emotion categorisation model that goes beyond mere categorical and dimensional approaches. Such model represents affective states both through labels and through four independent but concomitant affective dimensions, which can potentially describe the full range of emotional experiences that are rooted in any of us.

Keywords: Cognitive and Affective Modelling, NLP, Affective HCI.

1 Introduction

Emotions are an essential part of who we are and how we survive. They are complex states of feeling that result in physical and psychological reactions influencing both thought and behaviour. The study of emotions is one of the most confused (and still open) chapters in the history of psychology. This is mainly due to the ambiguity of natural language, which does not allow to describe mixed emotions in an unequivocal way. Love and other emotional words like anger and fear, in fact, are suitcase words (many different meanings packed in), not clearly defined and meaning different things to different people [1].

Hence, more than 90 definitions of emotions have been offered over the past century and there are almost as many theories of emotion, not to mention a complex array of overlapping words in our languages to describe them. Some categorisations include cognitive versus non-cognitive emotions, instinctual (from the amygdala) versus cognitive (from the prefrontal cortex) emotions, and also categorisations based on duration, as some emotions occur over a period of seconds (e.g., surprise), whereas others can last years (e.g., love).

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The James-Lange theory posits that emotional experience is largely due to the experience of bodily changes [2]. Its main contribution is the emphasis it places on the embodiment of emotions, especially the argument that changes in the bodily concomitants of emotions can alter their experienced intensity. Most contemporary neuroscientists endorse a modified James-Lange view, in which bodily feedback modulates the experience of emotion [3]. In this view, emotions are related to certain activities in brain areas that direct our attention, motivate our behaviour, and determine the significance of what is going on around us. Pioneering works by Broca [4], Papez [5], and MacLean [6] suggested that emotion is related to a group of structures in the centre of the brain called limbic system (or paleomammalian brain), which includes the hypothalamus, cingulate cortex, hippocampi, and other structures. More recent research, however, has shown that some of these limbic structures are not as directly related to emotion as others are, while some non-limbic structures have been found to be of greater emotional relevance [7].

Emotions are different Ways to Think [1] that our mind triggers to deal with different situations we face in our lives. Strong emotions can cause you to take actions you might not normally perform, or avoid situations that you generally enjoy. The affective aspect of cognition and communication, in fact, is recognised to be a crucial part of human intelligence and has been argued to be more fundamental in human behaviour and success in social life than intellect [8, 9]. Emotions influence cognition, and therefore intelligence, especially when this involves social decision-making and interaction. For this reason, human emotions and their modelling are increasingly understood to be a crucial aspect in the development of intelligent systems.

In particular, within sentic computing [10], a multi-disciplinary approach to opinion mining at the crossroads between affective computing and common sense computing, we developed a novel emotion categorisation model that allows to properly express the affective information associated with natural language text, for both emotion recognition and polarity detection tasks. A preliminary version of the model has already been used in some of our previous works [11–14], in which, however, no explicit motivations and details about the model were provided. The structure of the paper is as follows: Section 2 presents an overview of existing emotion categorisation models, Section 3 thoroughly explains motivations, peculiarities, and advantages of our model, Section 4, eventually, comprises concluding remarks and future directions.

2 Background

Philosophical studies on emotions date back to ancient Greeks and Romans. Following the early Stoics, for example, Cicero enumerated and organised the emotions into four basic categories: *metus* (fear), *aegritudo* (pain), *libido* (lust), and *laetitia* (pleasure). Studies on evolutionary theory of emotions, in turn, were initiated in the late 19th century by Darwin [15].

His thesis was that emotions evolved via natural selection and therefore have cross-culturally universal counterparts. In the early 1970s, Ekman found evidence that humans share six basic emotions: happiness, sadness, fear, anger, disgust and surprise [16]. Few tentative efforts to detect non-basic affective states, such as fatigue, anxiety, satisfaction, confusion, or frustration, have been also made [17–22] (Table. 1). In 1980, Averill put forward the idea that emotions cannot be explained strictly on the basis of physiological or cognitive terms. Instead, he claimed that emotions are primarily social constructs; hence, a social level of analysis is necessary to truly understand the nature of emotion [23].

The relationship between emotion and language (and the fact that the language of emotion is considered a vital part of the experience of emotion) has been used by social constructivists and anthropologists to question the universality of Ekman's studies, arguably because the language labels he used to code emotions are somewhat US-centric. In addition, other cultures might have labels that cannot be literally translated to English (e.g., some languages do not have a word for fear [24]). For their deep connection with language and for the limitedness of the emotional labels used, all such categorical approaches usually fail to describe the complex range of emotions that can occur in daily communication.

The dimensional approach [25], in turn, represents emotions as coordinates in a multi-dimensional space. For both theoretical and practical reasons, more and more researchers like to define emotions according to two or more dimensions. An early example is Russell's circumplex model [26], which uses the dimensions of arousal and valence to plot 150 affective labels (Fig. 1). Similarly, Whissell considers emotions as a continuous 2D space whose dimensions are evaluation and activation [27]. The evaluation dimension measures how a human feels, from positive to negative. The activation dimension measures whether humans are more or less likely to take some action under the emotional state, from active to passive (Fig. 2).

In her study, Whissell assigns a pair of values <activation, evaluation> to each of the approximately 9,000 words with affective connotations that make up her Dictionary of Affect in Language. Another bi-dimensional model is Plutchik's wheel of emotions, which offers an integrative theory based on evolutionary principles [28]. Following Darwin's thought, the functionalist approach to emotions

Table 1. Some existing definition of basic emotions. The most widely adopted model for affect recognition is Ekman's, although is one of the poorest in terms of number of emotions.

Author	#Emotions	Basic Emotions
Ekman	6	anger, disgust, fear, joy, sadness, surprise
Parrot	6	anger, fear, joy, love, sadness, surprise
Frijda	6	desire, happiness, interest, surprise, wonder, sorrow
Plutchik	8	acceptance, anger, anticipation, disgust, joy, fear, sadness, surprise
Tomkins	9	desire, happiness, interest, surprise, wonder, sorrow
Matsumoto	22	joy, anticipation, anger, disgust, sadness, surprise, fear, acceptance, shy, pride, appreciate, calmness, admire, contempt, love, happiness, exciting, regret, ease, discomfort, respect, like

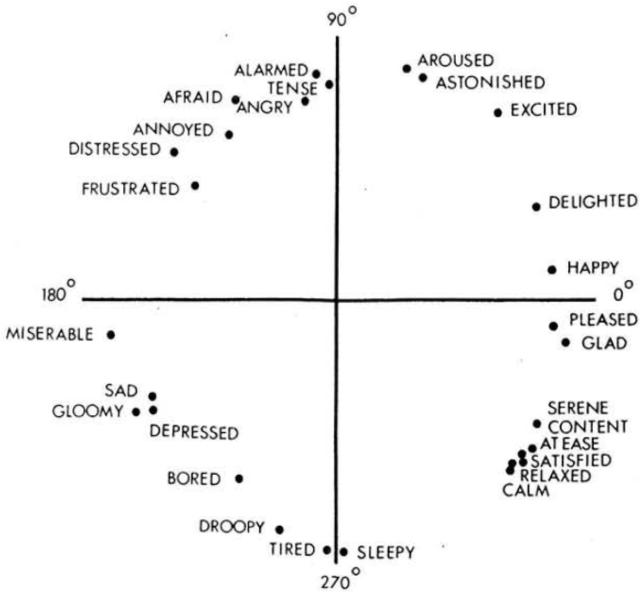

Fig. 1. Russell's circumplex model is one of the earlies examples of dimensional emotion representations. In the snippet, direct circular scaling coordinates are provided for 28 affect words.

holds that emotions have evolved for a particular function, such as to keep the subject safe [29, 30]. Emotions are adaptive as they have a complexity born of a long evolutionary history and, although we conceive emotions as feeling states, Plutchik says the feeling state is part of a process involving both cognition and behaviour and containing several feedback loops. In 1980, he created a wheel of emotions that consisted of 8 basic emotions and 8 advanced emotions each composed of 2 basic ones. In such model, the vertical dimension represents intensity and the radial dimension represents degrees of similarity among the emotions.

Besides bi-dimensional approaches, a commonly used set for emotion dimension is the <arousal, valence, dominance> set, which is known in the literature also by different names, including <evaluation, activation, power> and <pleasure, arousal, dominance> [31]. Recent evidence suggests there should be a fourth dimension: Fontaine et al. report consistent results from various cultures where a set of four dimensions is found in user studies, namely <valence, potency, arousal, unpredictability> [32].

Dimensional representations of affect are attractive mainly because they provide a way of describing emotional states that is more tractable than using words. This is of particular importance when dealing with naturalistic data, where a wide range of emotional states occurs. Similarly, they are much more able to deal with non-discrete emotions and variations in emotional states over time [33], since in such cases changing from one universal emotion label to another would not make much sense in real life scenarios.

Dimensional approaches, however, have a few limitations. Although the dimensional space allows to compare affect words according to their reciprocal distance, it usually does not allow to make operations between these, e.g., for studying compound emotions. Most dimensional representations, moreover, do not model the fact that two or more emotions may be experienced at the same time. Eventually, all such approaches work at word level, which makes them unable to grasp the affective valence of multiple-word concepts.

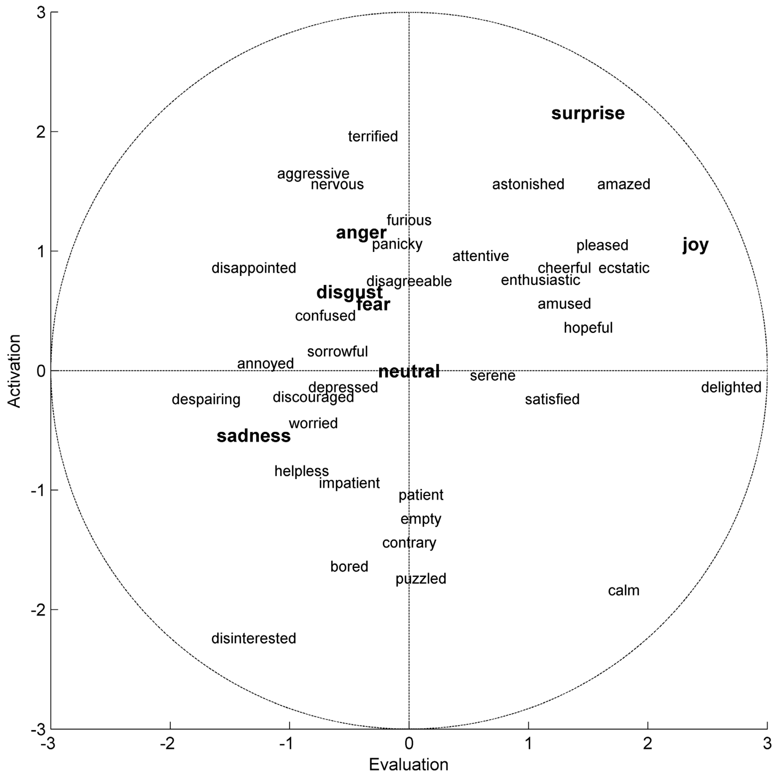

Fig. 2. Whissell's model is a bi-dimensional representation of emotions, in which words from the Dictionary of Affect in Language are displayed. The diagram shows the position of some of these words in the <activation, evaluation> space.

3 The Hourglass Model

The Hourglass of Emotions is an affective categorisation model primarily inspired by Plutchik's studies on human emotions [28]. It reinterprets Plutchik's model by organising primary emotions around four independent but concomitant dimensions, whose different levels of activation make up the total emotional state of the mind. The main motivation for the design of the model is the concept-level inference of the cognitive and affective information associated with text. Such faceted information is needed, within sentic computing, for a feature-based sentiment analysis, where the affective common sense knowledge associated with natural language opinions has to be objectively assessed.

Therefore, the Hourglass model systematically excludes what are variously known as self-conscious or moral emotions such as pride, guilt, shame, embarrassment, moral outrage, or humiliation [34–37]. Such emotions, in fact, may still present something of a blind spot for models rooted in basic emotions, because they are by definition contingent on subjective moral standards. The distinction between guilt and shame, for example, is based in the attribution of negativity to the self or to the act. So, guilt arises when believing to have done a bad thing, and shame arises when thinking to be a bad person. This matters because in turn, these emotions have been shown to have different consequences in terms of action tendencies. Likewise, an emotion such as *schadenfreude* is essentially a form of pleasure, but it is crucially different from pride or happiness because of the object of the emotion (the misfortune of another that is not caused by the self), and the resulting action tendency (do not express).

However, since the Hourglass model currently focuses on the objective inference of affective information associated with natural language opinions, appraisal-based emotions are not taken into account within the present version of the model. Several affect recognition and sentiment analysis systems [38–44] are based on different emotion categorisation models, which generally comprise a relatively small set of categories (Table 2). The Hourglass of Emotions, in turn, allows classifying affective information both in a categorical way (according to a wider number of emotion categories) and in a dimensional format (which facilitates comparison and aggregation).

3.1 A Novel Cognitive Model for the Representation of Affect

The Hourglass of Emotions is a brain-inspired and psychologically-motivated model based on the idea that the mind is made of different independent resources and that emotional states result from turning some set of these resources on and turning another set of them off [1]. Each such selection changes how we think by changing our brain's activities: the state of anger, for example, appears to select a set of resources that help us react with more speed and strength while also suppressing some other resources that usually make us act prudently. Evidence of this theory is also given by several fMRI experiments showing that there is a distinct pattern of brain activity that occurs when people are experiencing different emotions.

Zeki and Romaya, for example, investigated the neural correlates of hate with an fMRI procedure [46]. In their experiment, people had their brains scanned while viewing pictures of people they hated. The results showed increased activity in the medial frontal gyrus, right putamen, bilaterally in the premotor cortex, in the frontal pole, and bilaterally in the medial insula of the human brain. Also the activity of emotionally enhanced memory retention can be linked to

Table 2. An overview of recent model-based affect recognition and sentiment analysis systems. Studies are divided by techniques applied, number of categories of the emotion categorisation model adopted, corpora and knowledge base used.

Study	Techniques	#Categories	Corpora	Knowledge Base
[40]	NB, SVM	2	Political articles	None
[41]	LSA, MLP, NB, KNN	3	Dialogue turns	ITS interaction
[44]	Cohesion indices	4	Dialogue logs	ITS interaction
[42]	VSM, NB, SVM	5	ISEAR	ConceptNet
[43]	WN presence, LSA	6	News stories	WNA
[38]	WN presence	6	Chat logs	WNA
[39]	Winnow linear, C4.5	7	Children stories	None
[45]	VSM, KNN	24	LiveJournal	ConceptNet, WNA
[11]	VSM, k-means	24	YouTube, LiveJournal	ConceptNet, WNA, HEO
[14]	VSM, k-means	24	LiveJournal, PatientOpinion	ConceptNet, WNA
[12]	VSM, k-medoids	24	Twitter, LiveJournal, PatientOpinion	ConceptNet, Probase

human evolution [47]. During early development, in fact, responsive behaviour to environmental events is likely to have progressed as a process of trial and error. Survival depended on behavioural patterns that were repeated or reinforced through life and death situations. Through evolution, this process of learning became genetically embedded in humans and all animal species in what is known as 'fight or flight' instinct [48].

The primary quantity we can measure about an emotion we feel is its strength. But, when we feel a strong emotion, it is because we feel a very specific emotion. And, conversely, we cannot feel a specific emotion like fear or amazement without that emotion being reasonably strong. For such reasons, the transition between different emotional states is modelled, within the same affective dimension, using the function $G(x) = -\frac{1}{\sigma\sqrt{2\pi}}e^{-x^2/2\sigma^2}$, for its symmetric inverted bell curve shape that quickly rises up towards the unit value (Fig. 3). In particular, the function models how the level of activation of each affective dimension varies from the state of 'emotional void' (null value) to the state of 'heightened emotionality' (unit value). Justification for assuming that the Gaussian function (rather than a step or simple linear function) is appropriate for modelling the variation of emotion intensity is based on research into the neural and behavioural correlates of emotion, which are assumed to indicate emotional intensity in some sense.

In fact, nobody genuinely knows what function subjective emotion intensity follows, because it has never been truly or directly measured [49]. For example, the so-called Duchenne smile (a genuine smile indicating pleasure) is characterised by smooth onset, increasing to an apex, and a smooth, relatively lengthy offset [50]. More generally, Klaus Scherer has argued that emotion is a process characterised by non-linear relations among its component elements - especially

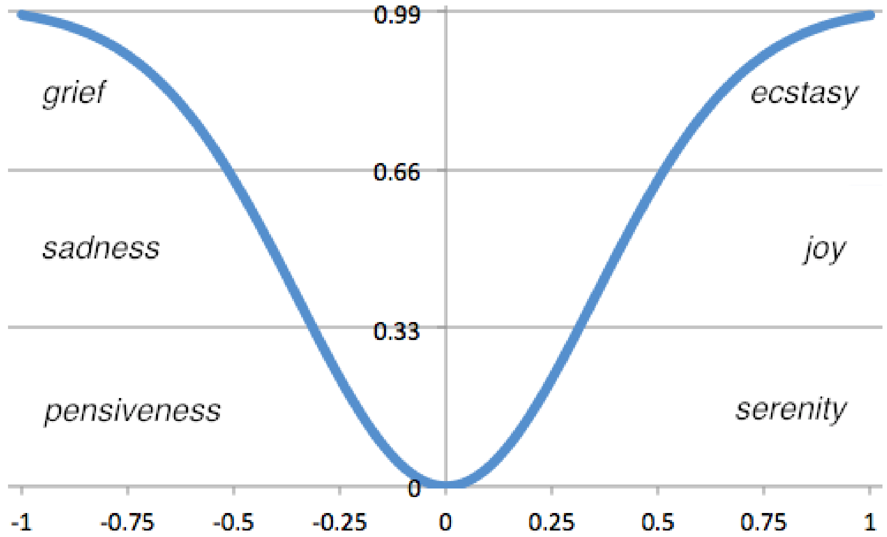

Fig. 3. The Pleasantness emotional flow. Within each affective dimension, the passage from a sentic level to another is regulated by a Gaussian function that models how stronger emotions induce higher emotional sensitivity.

physiological measures, which typically look Gaussian [51]. Emotions, in fact, are not linear [28]: the stronger the emotion, the easier it is to be aware of it.

Mapping the space of positive and negative primary emotions according to $G(x)$ leads to a hourglass shape (Fig. 4). It is worth to note that, in the model, the state of 'emotional void' is a-dimensional, which contributes to determine the hourglass shape. Total absence of emotion, in fact, can be associated with the total absence of reasoning (or, at least, consciousness) [52], which is not an envisaged mental state as, in human mind, there is never nothing going on.

3.2 A Model for Affective HCI

The Hourglass of Emotions can be exploited in the context of HCI to measure how much respectively: the user is amused by interaction modalities (Pleasantness), the user is interested in interaction contents (Attention), the user is comfortable with interaction dynamics (Sensitivity), the user is confident in interaction benefits (Aptitude).

Each affective dimension, in particular, is characterised by six levels of activation (measuring the strength of an emotion), termed 'sentic levels', which represent the intensity thresholds of the expressed/perceived emotion. These levels are also labelled as a set of 24 basic emotions [28], six for each of the affective dimensions, in a way that allows the model to specify the affective information associated with text both in a dimensional and in a discrete form (as shown in Table 3). The dimensional form, in particular, is called 'sentic vector'

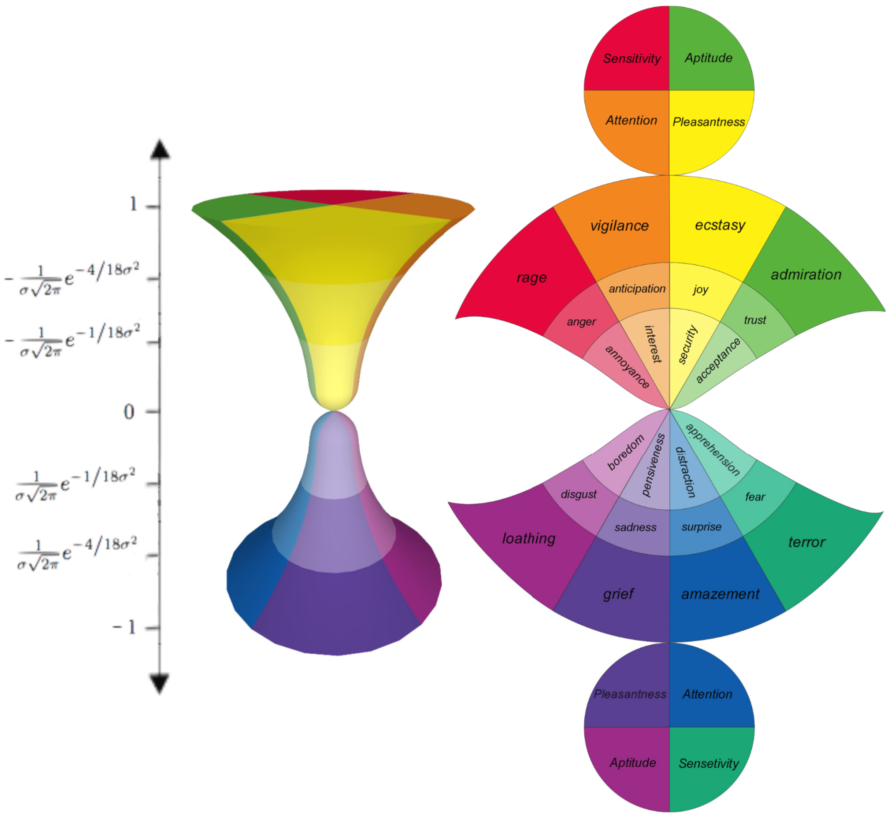

Fig. 4. The 3D model and the net of the Hourglass of Emotions: since affective states are represented according to their strength (from strongly positive to null to strongly negative), the model assumes a hourglass shape

and it is a four-dimensional *float* vector that can potentially synthesize the full range of emotional experiences in terms of Pleasantness, Attention, Sensitivity and Aptitude. In the model, the vertical dimension represents the intensity of the different affective dimensions, while the radial dimension models the activation of different emotional configurations, resembling Minsky's k-lines [53].

The model follows the pattern used in colour theory and research in order to obtain judgements about combinations, i.e., the emotions that result when two or more fundamental emotions are combined, in the same way that red and blue make purple. Hence, some particular sets of sentic vectors have special names as they specify well-known compound emotions (Fig. 5).

For example, the set of sentic vectors with a level of Pleasantness $\in$ [G(2/3), G(1/3)), i.e., joy, a level of Aptitude $\in$ [G(2/3), G(1/3)), i.e., trust, and a minor magnitude of Attention and Sensitivity, are called 'love sentic vectors' since they specify the compound emotion of love (Table 4). More complex emotions can be

Table 3. The sentic levels of the Hourglass model: each affective dimension contains six different levels of activation characterised by both a categorical and dimensional form

Interval	Pleasantness	Attention	Sensitivity	Aptitude
[G(1), G(2/3))	ecstasy	vigilance	rage	admiration
[G(2/3), G(1/3))	joy	anticipation	anger	trust
[G(1/3), G(0))	serenity	interest	annoyance	acceptance
(G(0), –G(1/3)]	pensiveness	distraction	apprehension	boredom
(–G(1/3), –G(2/3)]	sadness	surprise	fear	disgust
(–G(2/3), –G(1)]	grief	amazement	terror	loathing

synthesised by using three, or even four, sentic levels, e.g., joy + trust + anger = jealousy. Therefore, analogous to the way primary colours combine to generate different colour gradations (and even colours we do not have a name for), the primary emotions of the Hourglass model can blend to form the full range of emotional experiences that are rooted in anyone. Beyond emotion detection, the Hourglass model is also used for polarity detection tasks. Since polarity is strongly connected to attitudes and feelings, in fact, it can be defined in term of the four affective dimensions:

$$p = \sum_{i=1}^{N} \frac{Pleasantness(c_i) + |Attention(c_i)| - |Sensitivity(c_i)| + Aptitude(c_i)}{3N}$$

where c_i is an input concept, N the total number of concepts, and 3 the normalisation factor (as the Hourglass dimensions are defined as float $\in$ [-1,+1]).

Table 4. The second-level emotions generated by pairwise combination of the sentic levels of the Hourglass model. Different concomitant levels of activation give birth to different kinds of compound emotions, e.g., love, frustration, and anxiety.

	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

In the formula, Attention is taken in absolute value since both its positive and negative intensity values correspond to positive polarity values (e.g., surprise is negative in the sense of lack of Attention but positive from a polarity point of view). Similarly, Sensitivity is taken in negative absolute value since both its positive and negative intensity values correspond to negative polarity values (e.g., anger is positive in the sense of level of activation of Sensitivity but negative in terms of polarity).

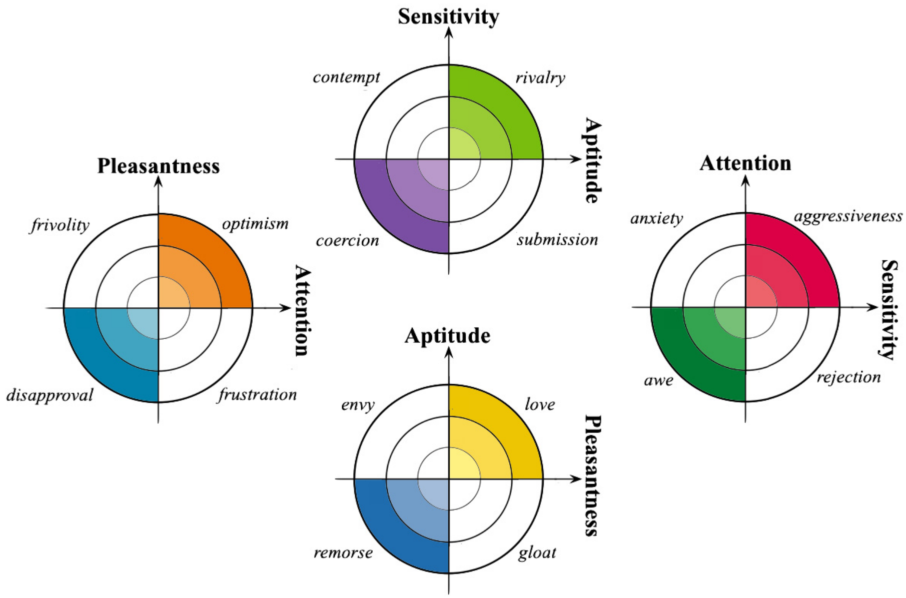

Fig. 5. Hourglass compound emotions of second level: by combining basic emotions pairwise it is possible to obtain complex emotions resulting from the activation of two of the four affective dimensions

4 Conclusion

Affective neuroscience and twin disciplines have clearly demonstrated how emotions and intelligence are strictly connected. Therefore, in order to enhance intelligent system processing and reasoning, it is necessary to provide machines with emotional models for time-critical decision enforcement.

Moreover, technology is increasingly used to observe human-to-human interactions, e.g., customer frustration monitoring in call centre applications. In such contexts, it is necessary to provide a suitable representation of emotional information, which should make the concepts and descriptions developed in the affective sciences available for use in technological contexts.

In this work, we developed the Hourglass of Emotions, a novel biologically-inspired and psychologically-motivated emotion categorisation model that goes beyond mere categorical and dimensional approaches. Such model represents affective states both through labels and through four independent but concomitant affective dimensions, which can potentially describe the full range of emotional experiences that are rooted in any of us.

In the future, we will be exploiting the model for the development of emotion-sensitive systems in different fields, in order to explore how much the model is generalisable and suitable for potentially any affective computing application.

We also plan to further modify the model in order to better represent compound emotions and to include the description of appraisal-based emotions.

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References

1. Minsky, M.: The Emotion Machine: Commonsense Thinking, Artificial Intelligence, and the Future of the Human Mind. Simon & Schuster (2006)
2. James, W.: What is an emotion? Mind 34, 188–205 (1884)
3. Dalgleish, T.: The emotional brain. Nature: Perspectives 5, 582–589 (2004)
4. Broca, P.: Anatomie comparée des circonvolutions cérébrales: Le grand lobe limbique. Rev. Anthropol. 1, 385–498 (1878)
5. Papez, J.: A proposed mechanism of emotion. Neuropsychiatry Clin. Neurosci. 7, 103–112 (1937)
6. Maclean, P.: Psychiatric implications of physiological studies on frontotemporal portion of limbic system (visceral brain). Electroencephalogr Clin. Neurophysiol. suppl.4, 407–418 (1952)
7. Ledoux, J.: Synaptic Self. Penguin Books (2003)
8. Vesterinen, E.: Affective computing. In: Digital Media Research Seminar, Helsinki (2001)
9. Pantic, M.: Affective computing. In: Encyclopedia of Multimedia Technology and Networking, vol. 1, pp. 8–14. Idea Group Reference (2005)
10. Cambria, E., Hussain, A.: Sentic Computing: Techniques, Tools, and Applications. Springer, Dordrecht (2012)
11. Cambria, E., Grassi, M., Hussain, A., Havasi, C.: Sentic computing for social media marketing. Multimedia Tools and Applications 59(2), 557–577 (2012), `http://dx.doi.org/10.1007/s11042-011-0815-0`
12. Cambria, E., Song, Y., Wang, H., Hussain, A.: Isanette: A common and common sense knowledge base for opinion mining. In: ICDM, Vancouver, pp. 315–322 (2011)
13. Cambria, E., Havasi, C., Hussain, A.: SenticNet 2: A semantic and affective resource for opinion mining and sentiment analysis. In: FLAIRS, Marco Island, pp. 202–207 (2012)
14. Cambria, E., Benson, T., Eckl, C., Hussain, A.: Sentic PROMs: Application of sentic computing to the development of a novel unified framework for measuring health-care quality. Expert Systems with Applications 39(12), 10533–10543 (2012), `http://dx.doi.org/10.1016/j.eswa.2012.02.120`
15. Charles, D.: The Expression of the Emotions in Man and Animals. John Murray (1872)
16. Ekman, P., Dalgleish, T., Power, M.: Handbook of Cognition and Emotion. Wiley, Chichester (1999)
17. Scherer, K.: Psychological models of emotion. The Neuropsychology of Emotion, 137–162 (2000)
18. Parrott, W.: Emotions in Social Psychology. Psychology Press (2001)
19. Prinz, J.: Gut Reactions: A Perceptual Theory of Emotion. Oxford University Press (2004)

20. Douglas-Cowie, E.: Humaine deliverable d5g: Mid term report on database exemplar progress. Technical report, Information Society Technologies (2006)
21. Kapoor, A., Burleson, W., Picard, R.: Automatic prediction of frustration. International Journal of Human-Computer Studies 65, 724–736 (2007)
22. Castellano, G., Kessous, L., Caridakis, G.: Multimodal emotion recognition from expressive faces, body gestures and speech. In: Doctoral Consortium of ACII, Lisbon (2007)
23. Averill, J.: A constructivist view of emotion. Emotion: Theory, Research and Experience, pp. 305–339 (1980)
24. Russell, J.: Core affect and the psychological construction of emotion. Psychological Rev. 110, 145–172 (2003)
25. Osgood, C., Suci, G., Tannenbaum, P.: The Measurement of Meaning. University of Illinois Press (1957)
26. Russell, J.: Affective space is bipolar. Journal of Personality and Social Psychology 37, 345–356 (1979)
27. Whissell, C.: The dictionary of affect in language. Emotion: Theory, Research, and Experience 4, 113–131 (1989)
28. Plutchik, R.: The nature of emotions. American Scientist 89(4), 344–350 (2001)
29. Frijda, N.: The laws of emotions. American Psychologist 43(5) (1988)
30. Freitas, A., Castro, E.: Facial expression: The effect of the smile in the treatment of depression. empirical study with portuguese subjects. In: Emotional Expression: The Brain and The Face, pp. 127–140. University Fernando Pessoa Press (2009)
31. Mehrabian, A.: Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament. Current Psychology 14(4), 261–292 (1996)
32. Fontaine, J., Scherer, K., Roesch, E., Ellsworth, P.: The world of emotions is not two-dimensional. Psychological Science 18(12), 1050–1057 (2007)
33. Cochrane, T.: Eight dimensions for the emotions. Social Science Information 48(3), 379–420 (2009)
34. Lazarus, R.: Emotion and Adaptation. Oxford University Press, New York (1991)
35. Lewis, M.: Self-conscious emotions: Embarrassment, pride, shame, and guilt. In: Handbook of Cognition and Emotion, vol. 2, pp. 623–636. Guilford Press (2000)
36. Scherer, K., Shorr, A., Johnstone, T.: Appraisal Processes in Emotion: Theory, Methods, Research. Oxford University Press, Canary (2001)
37. Tracy, J., Robins, R., Tangney, J.: The Self-Conscious Emotions: Theory and Research. The Guilford Press (2007)
38. Ma, C., Osherenko, A., Prendinger, H., Ishizuka, M.: A chat system based on emotion estimation from text and embodied conversational messengers. In: Int'l Conf. Active Media Technology, pp. 546–548 (2005)
39. Alm, C., Roth, D., Sproat, R.: Emotions from text: Machine learning for text-based emotion prediction. In: HLT/EMNLP, pp. 347–354 (2005)
40. Lin, W., Wilson, T., Wiebe, J., Hauptmann, A.: Which side are you on? identifying perspectives at the document and sentence levels. In: Conference on Natural Language Learning, pp. 109–116 (2006)
41. D'Mello, S., Craig, S., Sullins, J., Graesser, A.: Predicting affective states expressed through an emote-aloud procedure from autotutor's mixed-initiative dialogue. Int'l J. Artificial Intelligence in Education 16, 3–28 (2006)
42. Danisman, T., Alpkocak, A.: Feeler: Emotion classification of text using vector space model. In: AISB (2008)
43. Strapparava, C., Mihalcea, R.: Learning to identify emotions in text. In: ACM Symp. Applied Computing, pp. 1556–1560 (2008)

44. D'Mello, S., Dowell, N., Graesser, A.: Cohesion relationships in tutorial dialogue as predictors of affective states. In: Proceeedings of Conf. Artificial Intelligence in Education, pp. 9–16 (2009)
45. Grassi, M., Cambria, E., Hussain, A., Piazza, F.: Sentic web: A new paradigm for managing social media affective information. Cognitive Computation 3(3), 480–489 (2011)
46. Zeki, S., Romaya, J.: Neural correlates of hate. PloS One 3(10), 35–56 (2008)
47. Cahill, L., McGaugh, J.: A novel demonstration of enhanced memory associated with emotional arousal. Consciousness and Cognition 4(4), 410–421 (1995)
48. Bradford Cannon, W.: Bodily Changes in Pain, Hunger, Fear and Rage: An Account of Recent Researches into the Function of Emotional Excitement. Appleton Century Crofts (1915)
49. Barrett, L.: Solving the emotion paradox: Categorization and the experience of emotion. Personality and Social Psychology Review 10(1), 20–46 (2006)
50. Krumhuber, E., Kappas, A.: Moving smiles: The role of dynamic components for the perception of the genuineness of smiles. Journal of Nonverbal Behavior 29(1), 3–24 (2005)
51. Lewis, M., Granic, I.: Emotion, Development, and Self-Organization: Dynamic Systems Approaches to Emotional Development. Cambridge University Press (2002)
52. Csikszentmihalyi, M.: Flow: The Psychology of Optimal Experience. Harper Perennial (1991)
53. Minsky, M.: The Society of Mind. Simon and Schuster, New York (1986)