

Emotions in man and machine

An exploration of an emerging field

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Some questions

- What do we mean by emotion ?
- What is emotion ?
- Do emotions exist ?
- Do machines need emotions ?
- How we can make emotional machines ?

History of Emotions

- Many philosophers talked about emotion but emotions traditionally were thought:
 - In contrast (master-slave relation) with reason
 - Considered as “passions” (thus passive), uncontrollable, unreliable, bestial
 - Examined mainly in the context of ethics.

What do we mean by emotion ?

- You leave your home in a hurry take your car and start driving in heavy traffic
- Suddenly a car coming from the right lane overtakes you dangerously.
- Your heart starts to beat faster.
- You hit the brakes, your face muscles contract, you blow the horn.
- You feel angry.

Components of emotion

- You leave your home in a hurry take your car and start driving in heavy traffic
- Suddenly a car coming from the right lane overtakes you dangerously.
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Mood
Action tendency

Environment

Event

Cognition

Preparing the body

Physiology

Behavior

Feeling

What are emotions ?

- How can one discriminate between emotions and other affective phenomena ?
- How one can discriminate between various emotions ?

An emotion should be ...

- Triggered by an event
- Relevant to major concerns of the organism
- Synchronized mobilization of resources
- Interruptive
- Strong (Intensity) and Short (Duration)

What is not an emotion

- Preferences (likes and dislikes)
- Attitudes (including love)
- Mood (cheerful, gloomy, depressed)
- Affect dispositions (nervous, anxious, irritable, reckless, hostile, envious, jealous)
- Interpersonal stances (polite, distant, cold, warm, supportive)
- Aesthetic emotions ?

Discriminating between emotions

- Measure patterns of response
 - Measurement of emotion
 - Self Report
 - Forced choice
 - Free responses
- How can one then classify ?
 - Categorical
 - Dimensional

Feeling Theories

- James-Lang hypothesis
 - "we **feel** sorry because we cry, angry because we strike, afraid because we tremble, and it is not that we cry, strike, or tremble, because we are sorry, angry, or fearful, as the case may be"
- Damasio, Somatic Markers Hypothesis, Perceptual Theories

Appraisal Theories

- Transformation of an event to an evaluated event is often referred as **appraisal**.
- Emotions can therefore be viewed as processes that involve appraisal.
- Scherer
 - Pleasantness, goal significance, coping potential, compatibility with goals
- Fridja
 - Relevance, context, urgency, difficulty, action readiness

Cognitive Theories

- Emotions are (affect laden) judgments
- Emotions are sets of beliefs and desires
- Emotions are complexes of beliefs, desires and feelings
- What about fear of flying.

Social Constructivist Theories

- Emotions are complexes of feelings and attitudes which like other experiences and behaviours are social products.
- Love as an altruistic sentiment can only be found in post renaissance (or medieval) texts and not ancient texts.
- Emotions like anger differ in western (individualistic) vs east cultures (interdependent)
- Not everyone is capable of experiencing each emotion.

The evolutionary perspective

- Evolutionary psychology sees the brain as a zoo of programs that were evolved to solve domain specific problems (foraging, mate choice, face recognition).
- These programs have sometimes conflicting goals (e.g. flight and sleep).
- Emotions are therefore higher level programs that orchestrate these sub-programs e.g. switch on-off some programs when others are activated or modulate their parameters.

Neuroscience Perspective

- Limbic System Hypothesis
- No single “emotion” circuit. Several circuits that mediate/regulate many different emotions
- Panskeep’s model
 - Three levels of circuits: reflexive (lower-brain), mid (mammalian) brain, high-brain (neo-cortex)
 - Basic circuits: seeking/exploration, rage/anger, fear/anxiety, lust/sexuality, care/nurturing, panic/separation, play/joy
- Amygdala and fear (DeLoux)

Oatley & Johnson-Laird Theory

- Emotions are a part of a management system to coordinate each individual's multiple plans and goals under constraints of time and other limited resources
- Basic, object-oriented, complex emotions

Physiology of emotion

- *Emotions may “express” themselves through:*
 - Face (and Body)
 - Voice
 - ANS
 - Brain

Facial Expressions

- Measured by high speed filming and electromyography
- At least some discrete emotions are associated with distinct overt facial expressions (Eckman)
- Induced states in which individuals report positive and negative emotions are associated with distinctive facial actions
- displays similar to those in adults can be found in neonates and congenitally blind, suggesting that these expressions are inherently linked with biological mechanisms.

But ...

- Many emotional processes are not accompanied with visually perceptible facial expressions.
- Largely but not completely culture invariant
- May vary from one individual to another.
- Expression can be used to (fake) hide or mask the actual emotion.
- Contestants of the Eckman basic emotion theory say that the facial expressions reflect a communicative aspect and not the actual feeling.

Vocal Expressions

- Measurement
 - Temporal Measures (duration of words, pauses, phrases)
 - Intensity Measures (dB)
 - Fundamental frequency (Hz)
 - Combined Time-Frequency-Energy Measures: Complicated spectrum analysis techniques.

Acoustic correlates of emotion

- Mainly indicated correlation with arousal
 - High stress: >F0, >intensity, <utterance duration (faster speech)
 - Anger: >F0, >intensity, increase in high frequency energy
 - Fear: > intensity, >F0 range, increase in high frequency energy
 - Sadness: < intensity, < F0, slower speech
 - Joy: > F0, Intensity
 - Disgust: Not consistent results
 - Boredom: Slow speech, low F0
- Human listeners accuracy is about 60% (actors).

Autonomic Nervous System

- Heart rate: > anger, fear and sadness.
Anger, fear > happiness, fear > sadness
- Blood pressure: Anger > fear, sadness
- Skin conductance: fear > sadness
- Discrete emotions may not be differentiated by visceral activity alone.
- Negative emotions may be characterized by greater ANS activation

Brain

- Measurement of EEG asymmetry
- Correlate to positive/negative emotions



Emotion machines

Do machines need emotions ?

- Dr. Spock vs Dr. McCoy

"The release of emotion is what keeps us health. Emotionally healthy."

"That may be, Doctor. However, I have noted that the healthy release of emotion is frequently unhealthy for those closest to you."

McCoy and Spock, "Plato's Stepchildren", stardate 5784.3

- They need to have some sort of *emotional intelligence* to interact with humans

Emotional Intelligence

- Perceiving emotions
- Using emotions
- Understanding emotions
- Managing emotions

The Affective Computing Research Program

- *Affective Computing*
 - Machines can **measure emotion/affect** by observing behavior, physiology
 - They can subsequently act affectively and proactively
- *Applications*
 - “Natural” HCI (Embodied conversational agents)
 - Social sciences (psychology, psychiatry, neuroscience)
 - Therapy (autism, depression)
 - Intelligent services/devices
 - Social networks

Affective Computing and Perception of Affect

- Signal processing for measurement of behavioural/physiological expressions of emotion.
 - Facial expression recognition (static and dynamic)
 - Speech affect recognition
 - Psychophysiological signals (BP, CR, PPG, EEG)
- Classic pattern recognition (feature extraction, dimensional reduction, classification)

How good they are ?

- Maybe as good as humans (under controlled conditions)
- What to measure ?
 - Categorical or dimensional ?
 - Judgments or signs ?
- What is the ground truth ?
 - Acted/Posed emotions
 - Induced emotions
 - Spontaneous emotions
 - Reliability of annotation

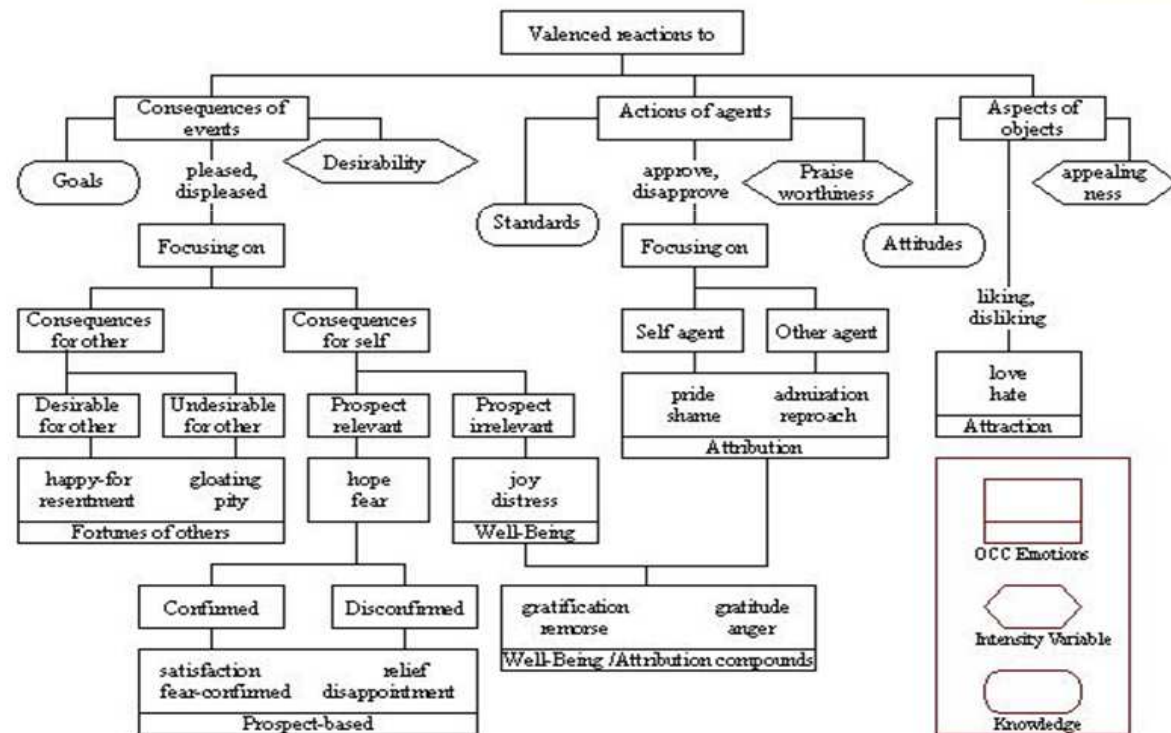
Open areas in affect perception

- Uncontrolled environments
- Subject independence
- Dynamics, Segmentation
- Novel cues (posture, head movements, gaze, body, para-linguistic etc.)
- Multimodality
- Use of context
- Subtle, Spontaneous
- **Limitations due to behaviorist premises**

Embodied Conversational Agents

- Successful HM communication requires that the communication partner is attributed with a form of personality (Cassell)
- Believable human like physical appearance and behavior (facial expressions, gestures etc.)
- Huge progress in computer graphics research.
- But, basically “emotionalizing” virtual agents or robots by “tweaks and tricks”.
- Recently, synthesis (and analysis) of emotions is driven by computational cognitive models.

Cognitive Models of Emotion: The OCC Model



... some successful demonstrations

- Agents for Healthcare and Training
 - Medical guidelines, patient education (persuasion).
 - Virtual training, therapy (progress evaluation)
- Games, Museums
 - Virtual poker player, museum guide

... and many open problems

- Models too shallow
- “Internal” effect of emotions on cognitive appraisal
- Emotion intensity and dynamics
- Multiple emotions (combine and integrate)

Emotion in Large-Scale Architectures for Human-level Intelligence

- SOAR and ACT-R extensions include emotions to modulate learning
- Minsky (The emotion machine)
 - “emotional states are not especially different from the processes that we call "thinking"; instead, emotions are certain ways to think that we use to increase our resourcefulness”
- Sloman (CogAff)
 - Reactive, deliberate (“what-if”), reflective processes
 - Emotions as a short if interrupt mechanism

Conclusion

- Emotion research: an emerging field in cognitive science
- Much more difficult than cognition/learning/language understanding: richness, ambiguity, multi-modality
- Computer scientists should take a step back and see the big picture.
- Real world applications should show the way.