Science, Technology and Humanity: Opportunities and Risks

Affective Computing

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http://dai.fmph.uniba.sk/courses/STH/

Affective computing

- **Computing** that relates to, arises from, or influences **emotions** (Picard, 1997).
- The study and development of systems and **devices that can recognize, interpret, process, and simulate human affects** (OpenMind BBVA).

Taxonomy

- **Affects in humans**
  - Monitoring
    - Facial expressions
    - Voice analysis
    - Posture, Movement, Gestures
    - Physiological markers
  - Influencing/Eliciting
    - Sensory-based / nudging
    - Direct brain stimulation
- **Affects in artificial systems**
  - Displaying emotional expressions
  - Implementing “Genuine”/behaviour modulating emotions

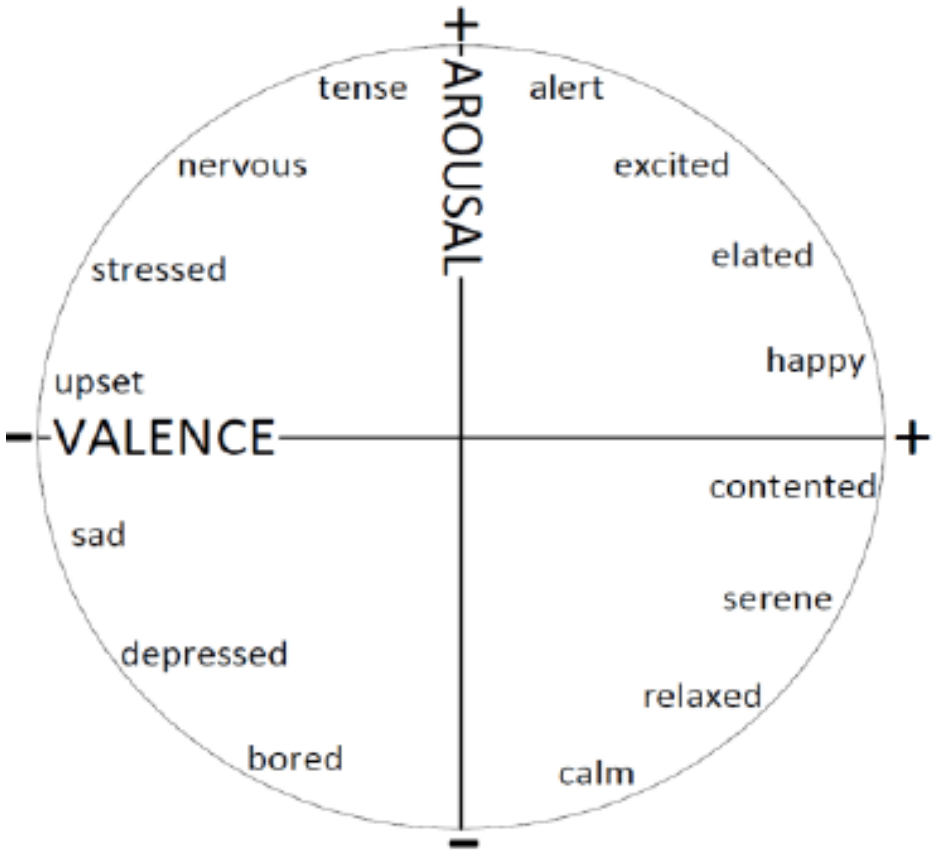
Affective states

- **Emotion:** a conscious mental reaction (such as anger or fear) subjectively experienced as strong feeling usually **directed toward a specific object** and typically **accompanied by physiological and behavioral changes** in the body (Merriam-Webster dictionary).
- **Mood: longer-term**, non-intentional (**not directed toward an object**), more **diffuse** affective mental state.

Theories of emotions

- Psychological
  - Dimensional theories – e.g. Russel's Circumplex model
  - Categorial models – e.g. Paul Ekman
  - Dynamical models – e.g. Scherer's appraisal theory
- Neuroscientific (e.g. Damasio, Panksepp)
- Social (e.g. Feldman-Barett)

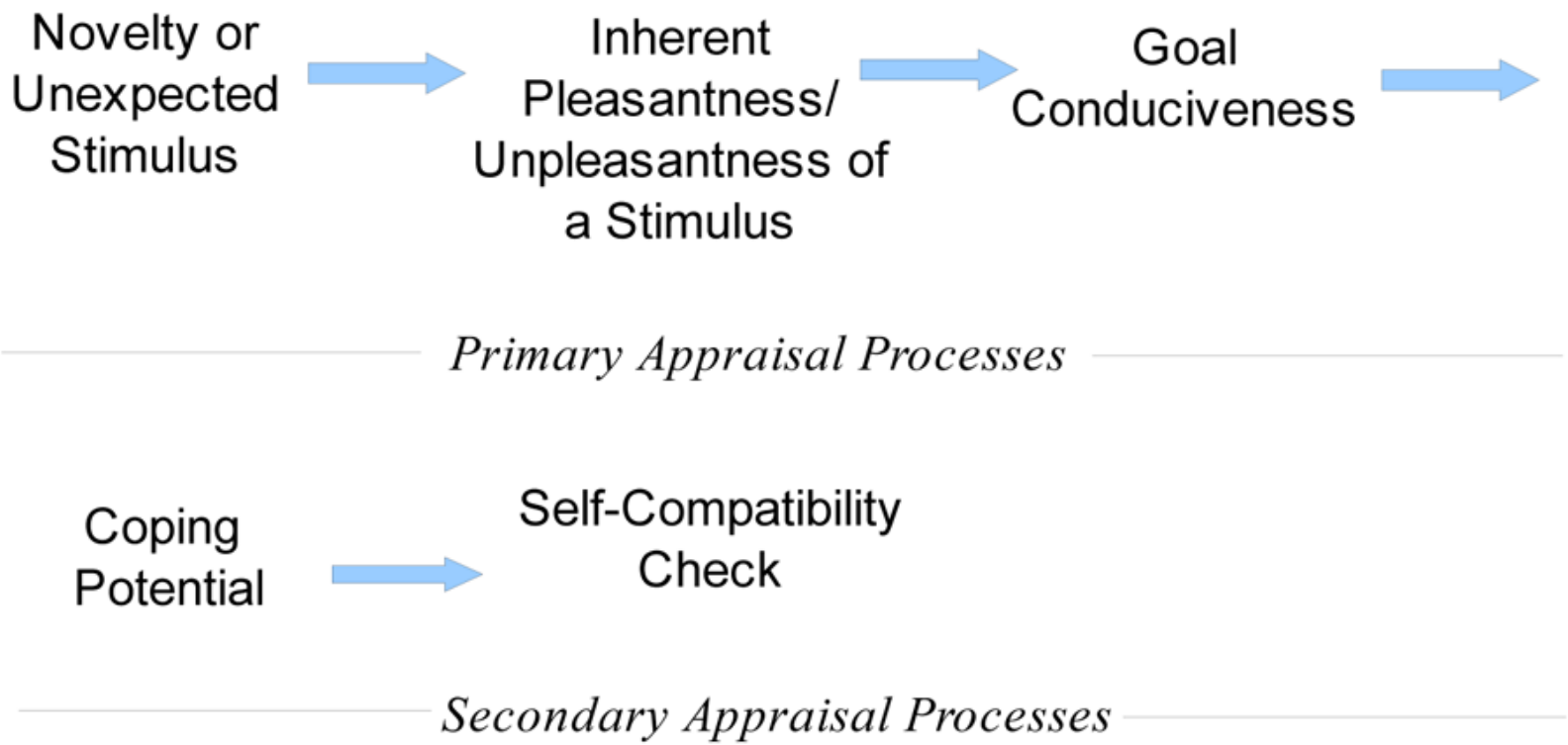
Russel's Circumplex model



Brain circuits based theories

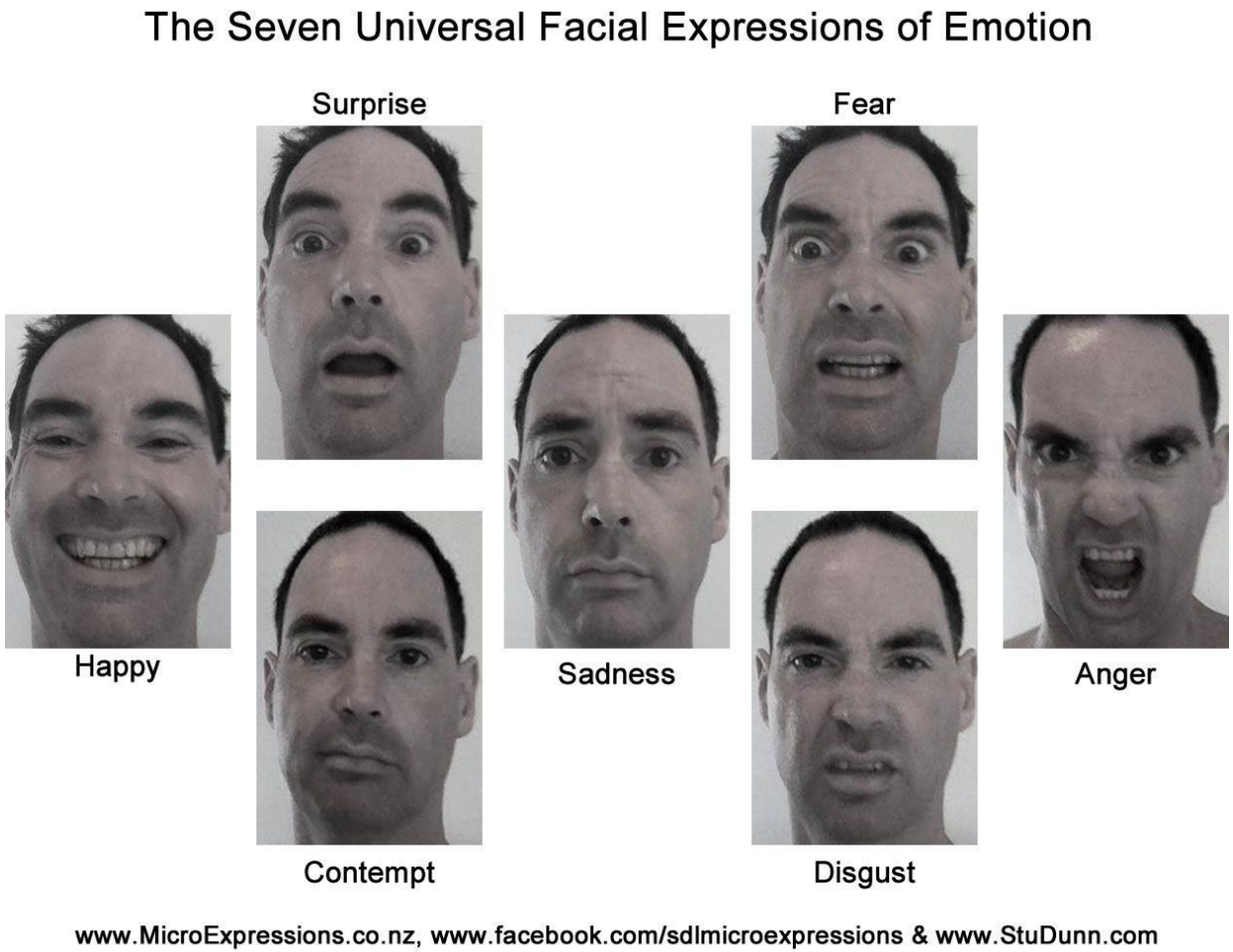
- Antonio Damasio
  - subcortical and cortical circuits directed at maintaining homeostasis
- Jaak Panksepp
  - distinct subcortical circuits featuring characteristic sets of neurochemicals: positive motivation/seeking, rage, fear, lust, care, (interpersonal connection), panic/grief (separation anxiety), and Play
- Luiz Pessoa
  - the neural signatures of basic emotions involve overlapping brain regions, both cortically and subcortically. There is no single brain region associated with any basic emotion. An emotional state is a **mode of connectivity between brain regions**

Scherer’s appraisal theory



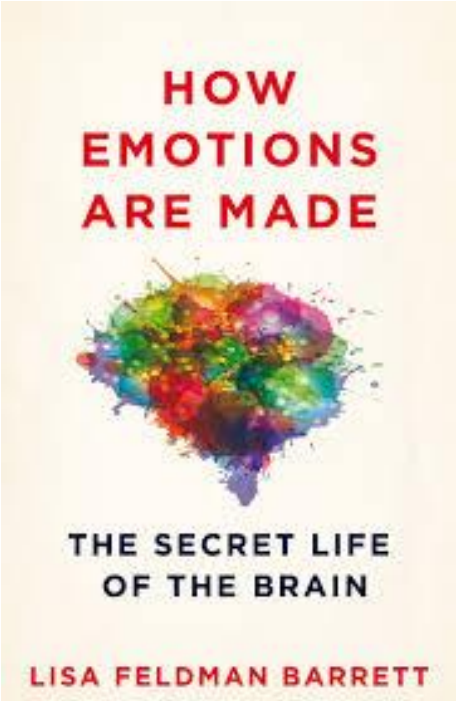
Leventhal & Scherer's Stimulus Evaluation Checks 1984-1987

Paul Ekman’s basic emotions



Feldman-Barett's theory of constructed emotions

- Emotions are dynamic, socially constructed and culturally mediated
- (also Boehner et. al, 2007)



Theories of emotions

- Objectivist/Representationist
- Constructivist/Enactive
  - Hanne de Jaeger

The paradigm influences AC software design choices: e.g. Freaky (Leahu & Sengers, 2014)

Roadmap

- Affects in humans
  - **Monitoring (emotion recognition)**
    - Facial expressions
    - Voice analysis
    - Posture, Movement, Gestures
    - Physiological markers
  - Influencing/Eliciting
    - Sensory-based / nudging
    - Direct brain stimulation
- Affects in artificial systems
  - Displaying emotional expressions
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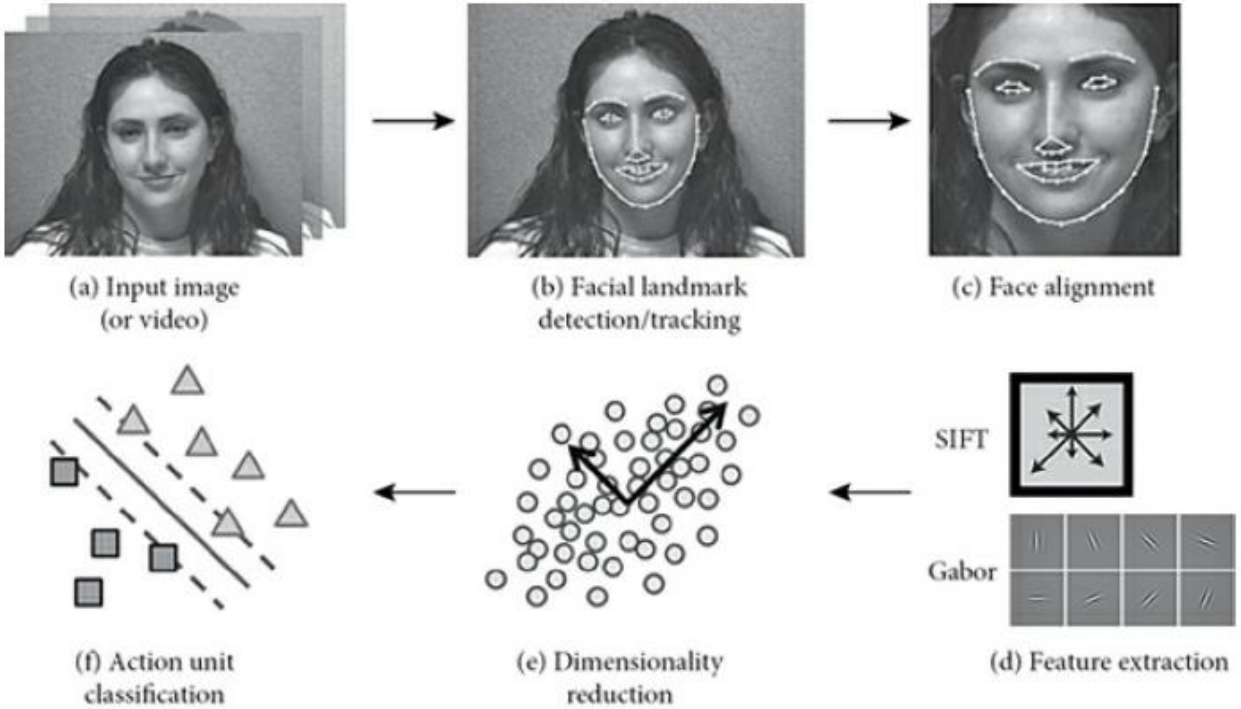
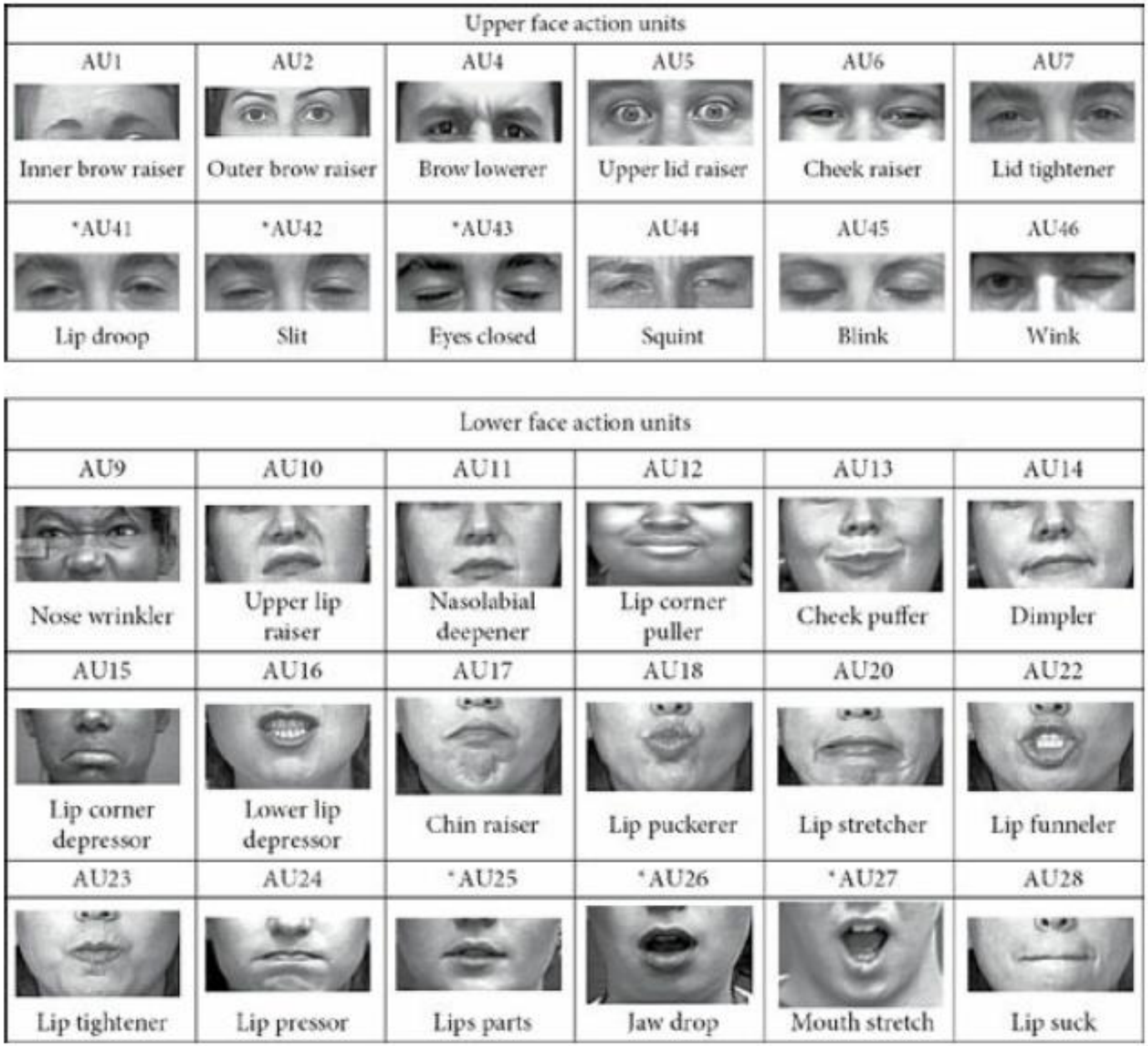
Automated face analysis (AFA)

- Facial action coding system (FACS, Ekman et al., 2002) describes facial activity in terms of anatomically based action units (AUs), facial muscles, combinations of edges, intersections



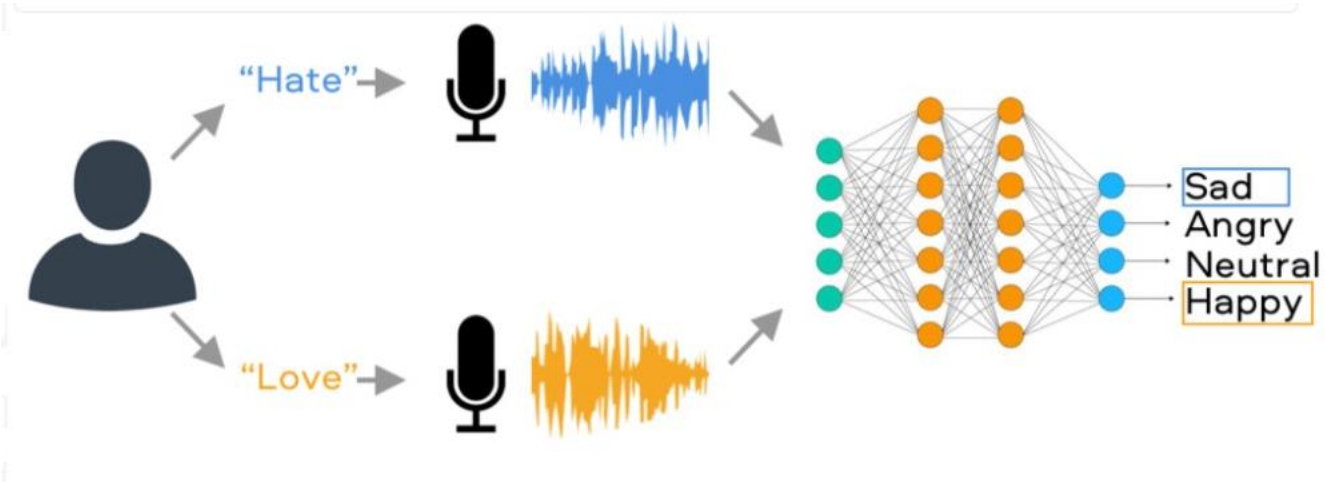
(Calvo et al., 2015)



(Ekman et al., 2002)

Voice analysis

- **Features:** spectral, prosodic and phonetic (speed, rhythm, variation in tone, gaps between words, pitch contours and loudness), ideolectic (choice of words), semantic
- Classification of audio signal time series



https://medium.com/limbic-ai/ethics-of-emotion-ai-part-1-cf2bbb2ca55a,

Voice analysis

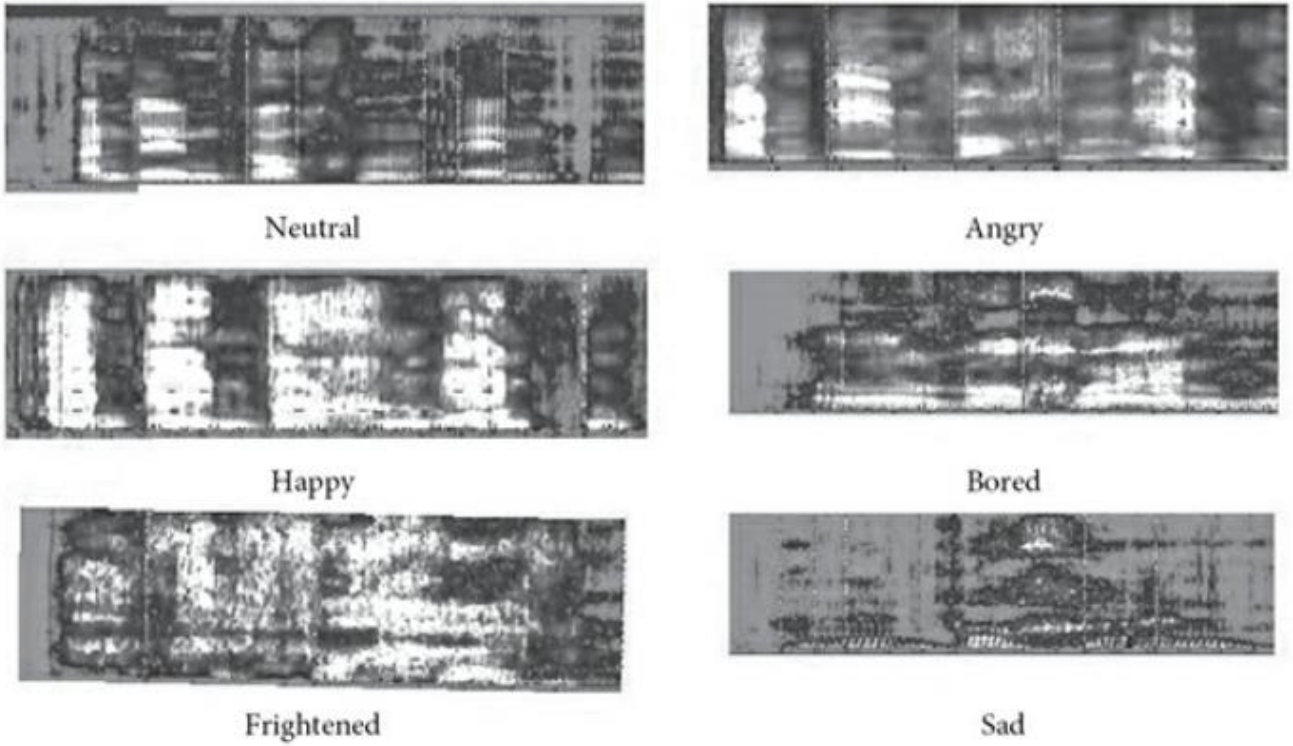


Fig. 20.2 Spectrograms from emotionally acted speech, always using the same sentence.

(Calvo et al., 2015)

Posture, Movement, Gestures

- Eye movement, openness and pupil dilation, gaze direction, head position, gait, posture, gestures, path of travel

Posture, Movement, Gestures

Table 19.1 Elements of Posture Expressing Specific Emotions

Emotion	Frequent Posture Features
Anger	Head backward, no chest backward, no abdominal twist, arms raised forward and upward, shoulders lifted
Joy	Head backward, no chest forward, arms raised above shoulder and straight at the elbow, shoulders lifted
Sadness	Head forward, chest forward, no abdominal twist, arms at the side of the trunk, collapsed posture
Surprise	Head backward, chest backward, abdominal twist, arms raised with straight forearms
Pride	Head backward or lightly tilted, expanded posture, hands on the hips or raised above the head
Fear	Head backward, no abdominal twist, arms are raised forward, shoulders forward
Disgust	Shoulders forward, head downward
Boredom	Collapsed posture, head backward, not facing the interlocutor

(Calvo et al., 2015)

Posture, Movement, Gestures

Table 19.2 Expressive Features of Arm Movement

Emotion	Frequent Features of Arm Movement
Anger	Lateralized hand/arm movement, arms stretched out to the front, largest amplitude of elbow motion, largest elbow extensor velocity, highest rising arm
Joy	High peak flexor and extensor elbow velocities, arms stretched out to the front
Sadness	Longest movement time, smallest amplitude of elbow motion, least elbow extensor velocity
Anxiety	Short movement time, constrained torso range of motion
Interest	Lateralized hand/arm movement, arms stretched out to the front
Fear	Arms stretched sideways

(Calvo et al., 2015)

Physiological markers

- Blood flow, heart rate and heart rate variability, electrodermal activity, breathing patterns, temperature, EEG signal.
- Wearable devices (smart wristband, EEG, ECG, …), affective BCI, e.g. EMOTIVE and Neurosky.

Other emotion recognition channels

- Location data
  - time spent in a location, speed, path, dynamic patterns of movement around certain types of locations
- Text
  - Explicit statements of emotion, tone from choice of words, choice of emoji
- Device and internet interaction patterns
  - Number and time of messages sent, keyboard force and use patterns, amount of time spent scrolling through and scanning content, social media likes and reactions

Applications (Greene, 2020)

- Detecting, treating or assisting with disease or disability
  - **emotion training**, identify increasing stress and stressors, and improve communication and understanding for people with autism and caregivers
  - **stress evaluation and relief**. Wearable cap that uses resting heart rate and EEG to measure stress and responds with soothing vibration and sounds
  - **pain detection**, to allow communication when patients cannot communicate pain verbally (agriculture: detect fear, pain, and disease in livestock)
  - **assessing and treating depression**,[35] anxiety[36] and other mental health conditions
  - **controlling wheelchairs** using facial gestures
  - self **mood tracking** for **gaining insight** about oneself

Applications (Greene, 2020)

- Wearables and stress relief
  - A wrist-worn wearable and companion app track electrodermal activity, temperature, and movement to predict when a user is anxious, stressed, or about to have an **epileptic seizure**.
  - Many companies are including heart rate analytics in wearables to **detect and track stress**

Applications (Greene, 2020)

- Social robots
  - fill a need for interaction and companionship.
  - companions, caregivers, pets, sex aids, home assistants, therapy coaches, tutors, or catalysts for human to human social interactions.
  - A social robot at home significantly **reduce symptoms of depression** in a majority of older adults with chronic depression living alone.
  - PARO, a social robot that is a plush baby seal, helps **reduce** behavioral and psychological **symptoms of dementia**.
  - **Children with autism talked more** with a human companion while interacting with a social robot dinosaur than while interacting with either a third person or with a computer game

Applications (Greene, 2020)

- Automotive and industrial safety
  - Automotive companies are using a variety of signals from the car and the driver including steering wheel angle, speed, sensors to detect lane markings, head orientation, and eyelid movements, to **evaluate driver alertness and distraction**, prompting alerts and suggestions to the driver to get a coffee or take a break
  - General Motors and BMW track a driver's head and eye positions as part of their semiautonomous driving systems, to **make sure drivers are watching the road** and prepared to take back control when they need to.
  - A major oil company, Chevron, is analyzing its truck drivers' faces for **signs of fatigue** to improve safety and productivity along fuel transport routes.

Applications (Greene, 2020)

- Threat detection/intervention and law enforcement
  - identify threats of violence, terrorism, and suicide, **detect lies** and fraud
  - A **social media** company uses users' posts and their contacts' responses and alerts local authorities if the company think there is an immediate **risk of suicide**.
  - Virtual **border agents** that use AI to **search for deception** in patterns of blood flow, subtle movements, and micro-gestures

Applications (Greene, 2020)

- Communities, politics
  - Capture, respond to, and influence the mood of a population or community. Understand patterns of emotional contagion.
  - An emotion based digital art gallery across Stockholm's metro and train system tries to **detect and improve commuters' moods**. It uses real-time public data gathered from Google searches, news articles, social media and travel traffic information to capture an overall mood in the population and then displays a picture chosen to **relieve** whichever **negative emotion** it detects

Applications (Greene, 2020)

- Education and audience engagement
  - Voice and face analysis are being used to **measure student engagement** and joy in video tutoring and classrooms in China.
  - Video cameras and AI **capture audience emotional reactions** and engagement at conferences, training events, and trade shows.
  - Colleges are basing **admissions decisions** in part on AI **predictions of students' interest** in the college, based on factors including how early in high school students interacted with the college's website and how quickly they responded to interview invitations.

Applications (Greene, 2020)

- Gaming, movies and entertainment (improving UX)
  - Disney and 20th Century Fox are experimenting with using infrared cameras and wearables to analyze facial expressions, heart rate, skin moisture and body movement, to understand audience emotions during theater test screenings with applications in **editing and targeted marketing**
  - Crowd reactions and player's facial expressions were used to **automatically identify tennis match highlights** during live TV coverage of the 2017 U.S. Open Tennis Championships.
  - Biofeedback for **increasing players' engagement** in computer games

Applications (Greene, 2020)

- Advertising and retail
  - maximize user engagement online, infer customer mood and interest from video, WiFi, motion sensors, to personalize advertising, understand product interest, and improve customer service.
  - In 2017, a four story digital billboard in London's Piccadilly **Circus chose ads based on the perceived age, gender and mood of people walking by**, and the make and model of passing cars in the background.
  - In a Chicago Walgreens drug store, smart drink cooler doors used the weather, motion sensors, cameras and AI estimates of customer gender, age, gaze direction and emotional response to **determine which ads to display**.
  - A patent held by Walmart describes **estimating a shopper's level of agitation or annoyance** from biometric data, including heart rate or blood pressure, extracted from video cameras at the checkout line, and combining it with purchase history information.

Applications (Greene, 2020)

- Chatbots, call centers, and home/auto voice assistants
  - Call centers are using AI to **monitor both callers' and agents' mood**
  - Chatbots and voice assistants can **modulate their tone and responses** based on perceived user emotion, can use emotion as a cue to pass the call to a live agent, and can **offer emotional relief** to some users by getting those users to talk without feeling fearful or judged

Applications (Greene, 2020)

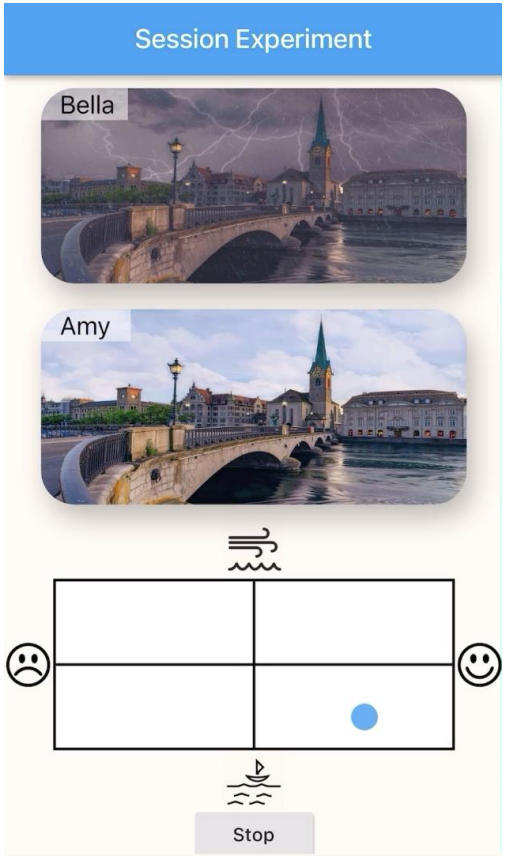
- Hiring and employment
  - A video interview analysis company, Hirevue, uses facial expressions to capture moods to **evaluate job candidates**.
  - An early stage happiness monitoring wearable would combine heart-rate data with calendar data to **determine which meetings or colleagues at the office cause stress**.
  - McDonald's is using facial analysis in its Japanese restaurants to **detect whether employees are smiling while assisting customers** to improve customer service.

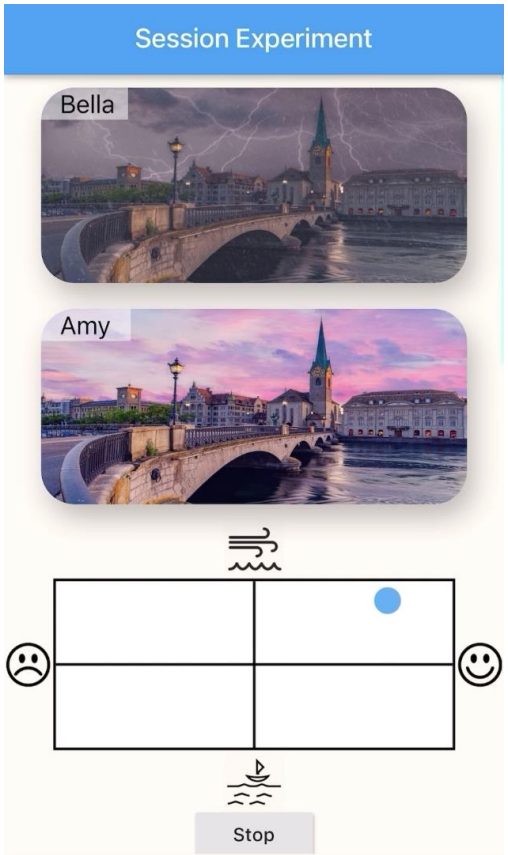
Applications (Greene, 2020)

- COVID-related
  - **Alleviate mental health problems** caused by stress, economic crisis, and ventilator use
  - Social robots could help **reduce human proximity** and disease transmission
  - Monitor **engagement** or read their audiences' reactions **during online meetings**, lectures, and events were in person
  - Increase **sense of connectedness** in remote communication

Affective state cues in online communication

- Research: Dina Talypova, app: Ouassim Fari





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Influencing user’s affective state

- Affect induction procedures (Joseph et al., 2020)
  - Pictures, Music/Sounds, Film, Odor, Altering the environment,
  - Face/Body manipulation
  - Coping challenge, social pressure
- Direct brain stimulation
  - Electric stimulation of amygdala (fear, happiness)
  - Closed-loop (bio-feedback systems)
  - Deep brain stimulation (DBS) via implanted electrodes

Ethical issues, misuse, malicious applications

- Can you think of any?

Ethical issues (Steinert & Friedrich, 2020)

- Risk of infection or brain tissue injuries (for invasive forms)
- Informed consent: understanding the (long-term) consequences of detecting, influencing and stimulating affective states via affective BCIs can be difficult
- Data security, privacy, neuro-hacking

Ethical issues (Steinert & Friedrich, 2020)

- **Mental privacy** – who has right to read my mental states?
  - Employers – to increase effectivity and obedience
  - Marketing companies – to increase sales
  - Military – to better control soldiers, increase aggression etc.
  - Police – investigation / torture?

Ethical issues (Steinert & Friedrich, 2020)

- **Self-tracking** and self-quantification
  - can foster (gender, age) **stereotypes and biases** about "normal" affective behaviour
  - disciplining effects of self-tracking could infringe on **autonomy and authenticity**
  - The ability of humans to notice, to control and to cultivate emotions in order to be a moral person has been a key issue of ethics throughout history. Outsourcing such decisions to technology can lead to **alienation from emotions**.

Ethical issues (Steinert & Friedrich, 2020)

- **Nudging** – influencing behaviour without forcing
  - Affect manipulation is ideal for nudging
  - **Mental integrity:** nobody should monitor or manipulate people's mental states or brain data without their consent – may require legal protection
    - Micro-targeting in political campaigns and elections – thread to democracy
    - Nudging to buy certain goods
  - Nudging can also have beneficial effects
  - Question of **responsibility for decisions**
  - Implications for **what it means to be human**

Ethical issues (Steinert & Friedrich, 2020)

- Direct brain stimulation
  - DBS may potentially **undermine agency and personal identity** and lead to **self-estrangement**
  - Manipulation of emotions has a direct **bearing on the constitution of the self** (via autobiographical memories).
  - **Military applications**: suppression of fear, remorse and empathy, increasing courage and anger – issue of **moral responsibility** in decision-making

Conclusion

- Long history of influencing emotions (alcohol, synthetic drugs, entertainment).
- Potential to influence emotional self-regulation, autobiographic memory, sense of self, identity, autonomy, authenticity and responsibility ascriptions will have a deep impact on individuals and on society

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Affects in artificial systems

- … will talk about in the lecture on Artificial mind

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