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Social Gaming / Social Computing SS 2015

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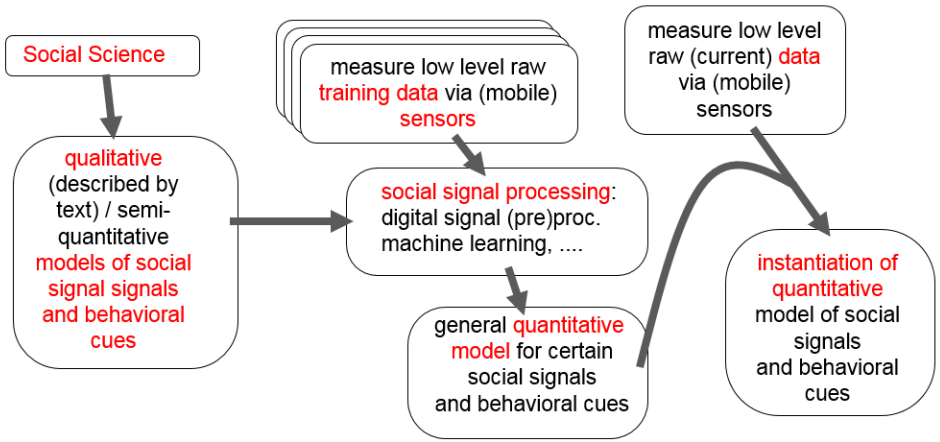
Social Signal Processing

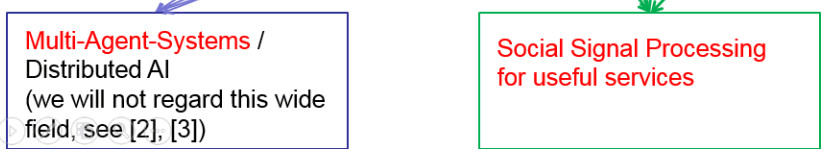
- Up to now: most emphasis on long term social context (e.g. networks of friendships)
- Now: short term social context: social behavior on small spatial and temporal scales: detection + applications



Social Signal Processing

- **Social intelligence** (humans): Ability to express and recognize social signals / social behaviors from other human individuals
  in order to „function" in a society with other human individuals
  in view of (pareto-)optimizing own and other human's
  utility function (survival, reproduction) via cooperation (modified from [1])

- **Social intelligence** (IT systems): Ability to express and recognize social signals / social behaviors from other human and IT-agent individuals
  in order to „function" in a society with other human and IT-agent individuals
  in view of (pareto-)optimizing own and other IT agent's and fellow human's
  utility function (survival, reproduction, ..) via cooperation



Where and how to use SSP techniques for improving services?

- Socially smart services: examples:
  - -- recommender systems:
    use short term *individual* context detected via SSP:
    ++ emotional state → prefer to recommend funny movies when depressed
    (caveat: not social!!)
  - use short term *social* context detected via SSP:
    ++ social situation → use group recommender:
    recommend pareto optimal choices
- etc.

Common name for paradigm: Socially Aware Computing

distinguished from / subclass of: Context Aware Computing
distinguished from: Personalization

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SSP and Reality Mining

- Reality Mining: Field of study / application defined by Alex Pentland (MIT)
  - Analyzing all available traces of human behavior (social and also non-social)
  - → derive models for this behavior → scientific knowledge and applications (e.g. prediction)
  - special focus on „non-virtual“, „direct“, „physical“ behaviors recordable via mobile sensors (calling patterns, location, acceleration patterns etc.)
  - not excluded but not in main focus: large networks arising from long term social relations, analysis of communication content etc.
- Reality Mining may use SSP techniques

Social Signals and Behavioral Cues

- Examples of Social Behavior: Expressing attitude towards elements of a social setting:

  -- Mirroring (if mutual attraction)
  -- aggressive turn taking behavior
  -- expression diapproval of sth. (e.g. via disapproving looks)
  -- expression of sympathy / empathy

- Examples for Behavioral Cues:

  -- facial expressions
  -- body posture / interaction geometry
  -- gestures
  -- expressives (laughter etc.)
  -- emotions reflected in speech prosody (rhythm, intonation, stress)

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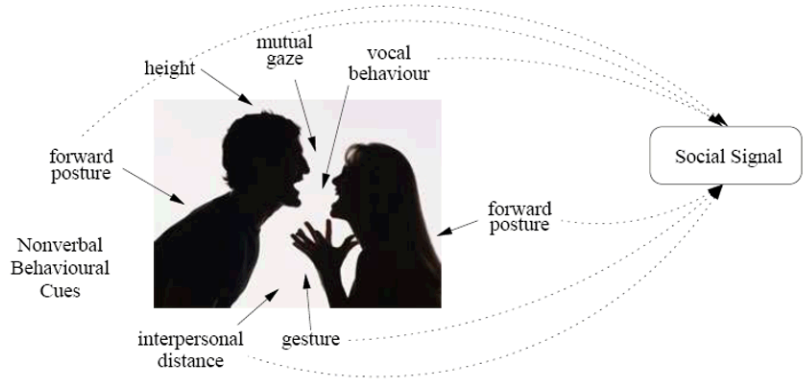

Fig. 1. Behavioural cues and social signals. Multiple behavioural cues (vocal behaviour, posture, mutual gaze, interpersonal distance, etc.) combine to produce a social signal (in this case aggressivity or disagreement) that is evident even if the picture shows only the silhouettes of the individuals involved in the interaction.

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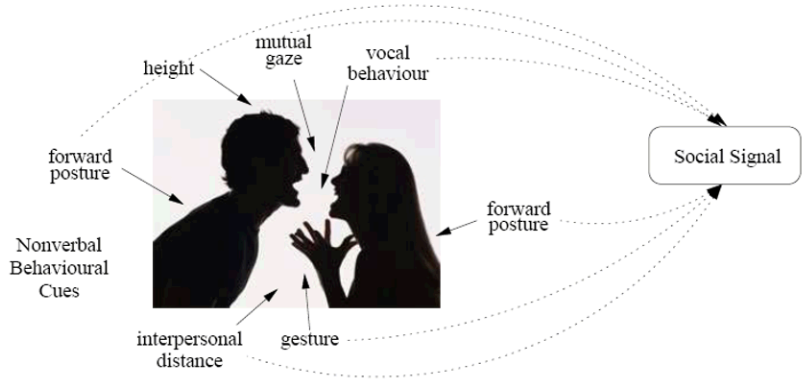
Social Signals and Behavioral Cues



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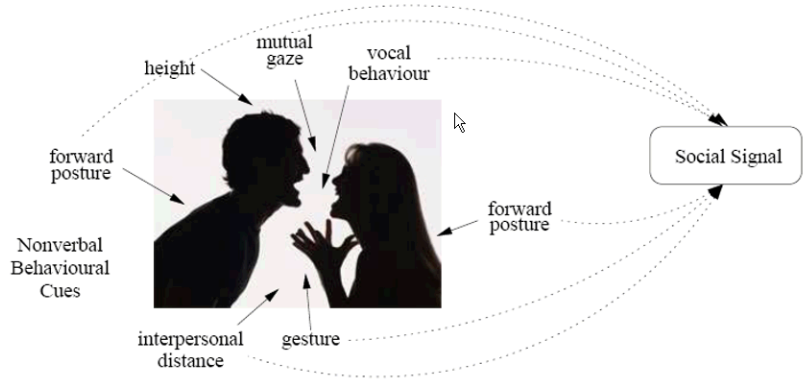

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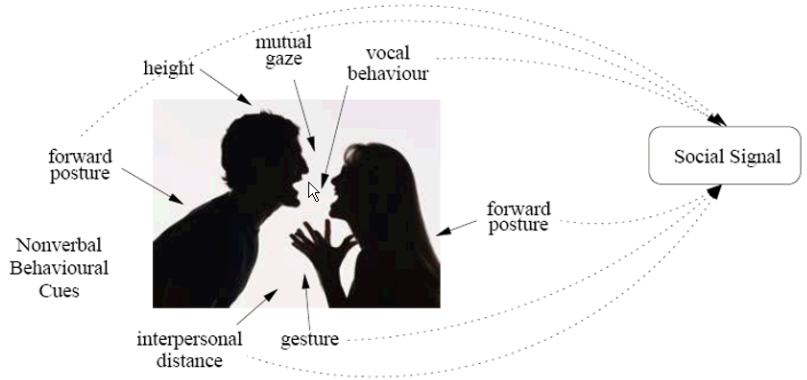

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Social Signals, Social Behavior, Behavioral Cues

- (Non-verbal) (Social) Behavioral Cues: „composed of“ / manifested via (series of / parallel / overlapping / single ...) time-series of perceivable or measurable, non-verbal physiological activity.
  (neglecting content of communication)
- (Non-verbal) Social Signals (conscious or unconscious): „composed of“ / manifested via (series of / parallel / overlapping / single ...) Behavioral Cues
- (Non-verbal) Social Behavior: „composed of“/ manifested via (series of / parallel / overlapping / single ...) Social Signals.

- Humans: perceived Social Behavior of other humans
  → Social Awareness
- Non-verbal social signalling + behavior: conveys / determines most of social perception of others (compared to e.g. verbal *content* *(only 7 %)*)

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Social Signals, Social Behavior, Behavioral Cues

- Temporal domain:
  - Social Signals + Behavioral Cues :
    - typically: microseconds to seconds
  - Social Behavior:
    - minutes to hours or longer

- Types of „messages“ conveyed by Behavioral Cues:

have direct verbal translation, people are aware of

adaptators : involuntary, habitual, honest (e.g. folding arms, crossing away legs)

regulate turn taking and other conversational aspects

- *affective/attitudinal/cognitive states* (e.g. fear, joy, stress, disagreement, ambivalence and inattention),
- *emblems* (culture-specific interactive signals like wink or thumbs up),
- (*manipulators*)(actions used to act on objects in the environment or self-manipulative actions such as lip biting and scratching),
- *illustrators* (actions accompanying speech such as finger pointing and raised eyebrows), and
- *regulators* (conversational mediators such as the exchange of a look, palm pointing, head nods and smiles).

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- Table of Behavioral cues:

Behavioral Cues:	Example Social Behaviours (aspects of) emotion	personality	status	dominance	persuasion	regulation	rapport (*)	Tech. speech anlysis	computer vision	biometry
Physical appearance										
height			√	√					√	√
attractiveness		√	√	√	√		√		√	√
body shape		√		√					√	√
Gesture and posture										
hand gestures	√	√			√	√	√		√	√
posture	√	√	√	√	√	√	√		√	√
walking		√	√	√					√	√
Face and eyes behaviour										
facial expressions	√	√	√	√	√	√	√		√	√
gaze behaviour	√	√	√	√	√	√	√		√	
focus of attention	√	√	√	√	√	√	√		√	
Vocal behaviour										
prosody	√	√		√	√		√	√		
turn taking	√	√	√	√		√	√	√		
vocal outbursts	√	√		√	√	√	√	√		
silence	√		√				√	√		
Space and Environment										
distance	√	√	√		√		√		√	
seating arrangement				√	√		√		√	

(*) mutual trust vs. distrust

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Physical Appearance

- „Implicit“ „Behavioral“ Cues / Social Signals
  - natural characteristics (e.g. body shape)
  - artifical characteristics (e.g. make up)
- Especially important for attractiveness → halo effect (“what is beautiful is good”);
- other example of effect mechanism: height, sematotype → power, influence, strength

Fig. 2. Somatotypes. The figure shows the three body shapes that tend to elicit the perception of specific personality traits. [1]

Gestures and Posture

- Gestures and posture are related to e.g. expressed emotions (examples: inclination of head, touching own head (various), posture shifts →shame, embarrassment)
  - 90% of gestures : associated with speech (social signals / social signal aspects: illustrators, emblems, regulators etc.)
- unconscious gestures / posture : „honest“ signals → allow to deduce „actual“ / „true“ state / social attitude / etc.
  - Example: adaptators: unconscious expressions of internal states or social attitudes, e.g. manipulation of own body parts (e.g. hair twisting), or objects (e.g. playing with pens); protective gestures (folding arms, rythmically moving legs etc.)

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Gestures and Posture

- Posture: very important Behavioral cues:
  considered as among the most reliable cues
  about actual social attitude towards (elements of) a social setting
- (partly overlapping) Classification axes for postures in interactive social settings:
  - Inclusive vs exclusive postures
  - relative body orientation
  - congruent vs incongruent (→ mirroring)

Congruent postures

Non−congruent postures [1]

- Postures in „general“ social environments:
  may reveal sth. about individual state or general social attitude:
  example: walking style (→ status, dominance)

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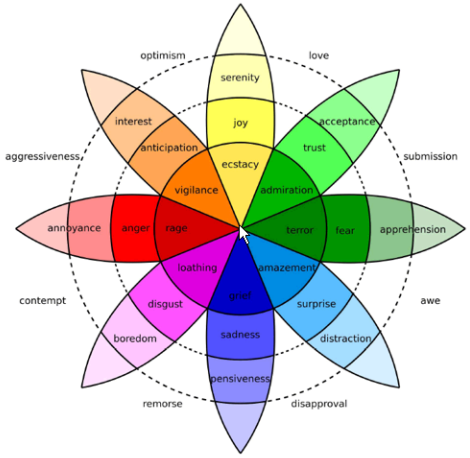
Interaction Geometry

- Interaction geometry: special aspects of posture and space and environment:
  relative geometry of interacting persons:
  -- relative body angle
  -- interpersonal distances
  -- relative body positions
- → we will take a more extensive look at a specific example later

Emotion Enconding Systems

- System to describe (basic) message:
  - 6 basis emotions (Ekman):
    fear, sadness, happiness,
    anger, disgust, surprise
- Plutchik's Wheel of Emotion:



Plutchik's Wheel of Emotion. Source: [Plutchik, 2012; in (1)]

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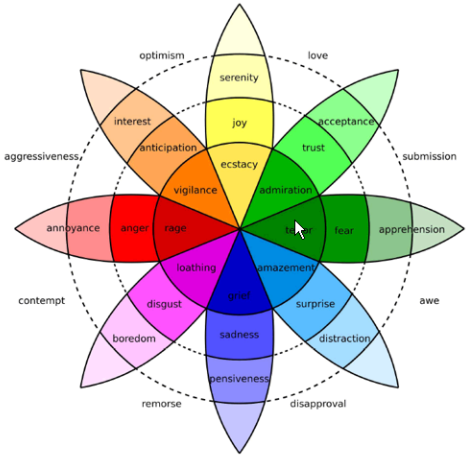

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Face and Eye Behavior

- System to describe facial expressions and facial actions:
  Facial Action Coding System (FACS):
  Action Units (AUs):

  Smallest discernable movements of a distinct muscle / muscle group in a face which may take part in facial expressions and facial actions and that may be algorithmically detected

  -- 9 AUs in upper face
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  -- 14 additional descriptors

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Face and Eye Behavior

- Example studies: FACS patterns → social signals / individual states: recognition of
  - basic emotions
  - cognitive states like interest and puzzlement
  - psychological states like suicidal depression or pain
  - social behavior aspects like rapport (mutual trust vs. distrust),
  - personality traits like extraversion and temperament
  - social signals : e.g. status, trustworthiness,
    emblems (wink, thumbs up, etc.),
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Face and Eye Behavior

- Interesting studies: FACS + classifiers can be better at distinguishing between deception and intoxication (and also between lying and telling the truth) than humans

Vocal Behavior

- Components:
  - voice quality (Prosody)
  - linguistic vocalizations (Segregates)
  - non-linguistic vocalizations
  - silence patterns
  - turn taking patterns

Vocal Behavior

- Silence patterns:
  - -- hesitiation silence: (e.g. ← explaining difficult concepts)
  - -- psycholinguistic silence: ← (language) en-/de-coding difficulties
  - -- interactive silence: expressing respect, doubt, ignoring persons, attract attention to other forms of communication (e.g. gazes)
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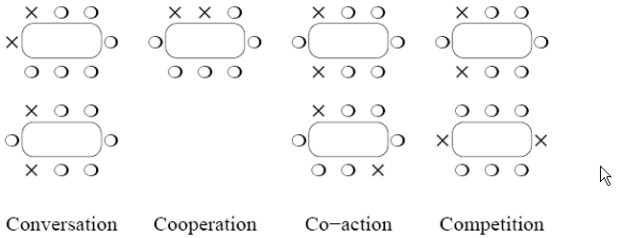
Space and Environment

- Seating arrangements ←→ personality (dominance etc.), social status



Social Signal Processing Chain

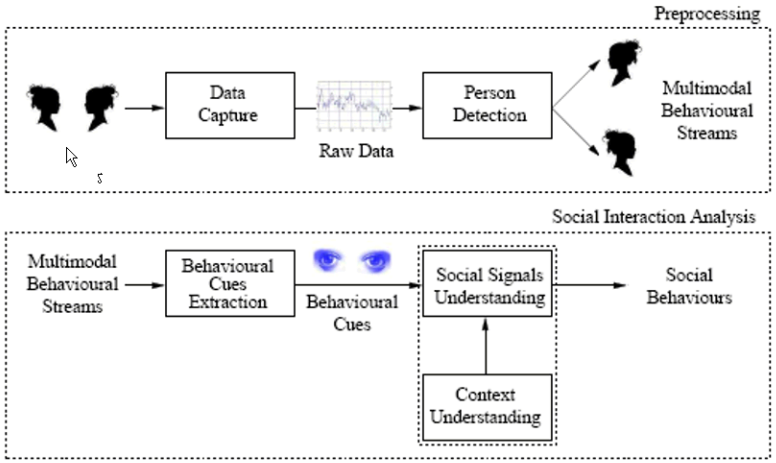


Fig. 6. Machine analysis of social signals and behaviours: a general scheme. The process includes two main stages: The *preprocessing*, takes as input the recordings of social interaction and gives as output the multimodal behavioural streams associated with each person. The *social interaction analysis* maps the multimodal behavioural streams into social signals and social behaviours. [1]

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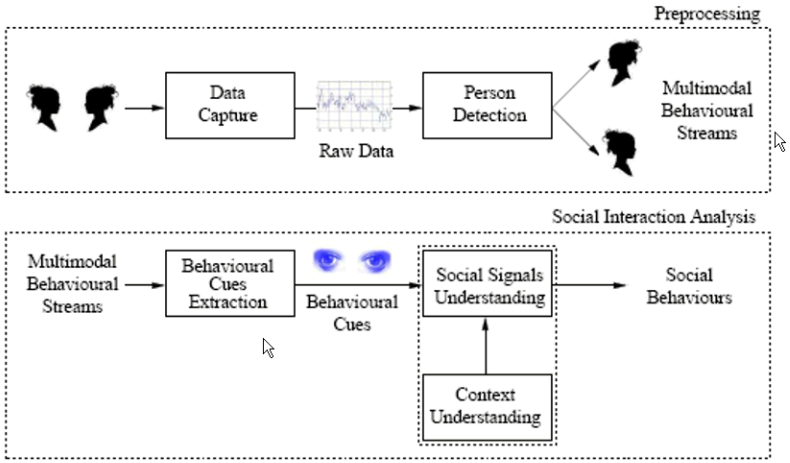

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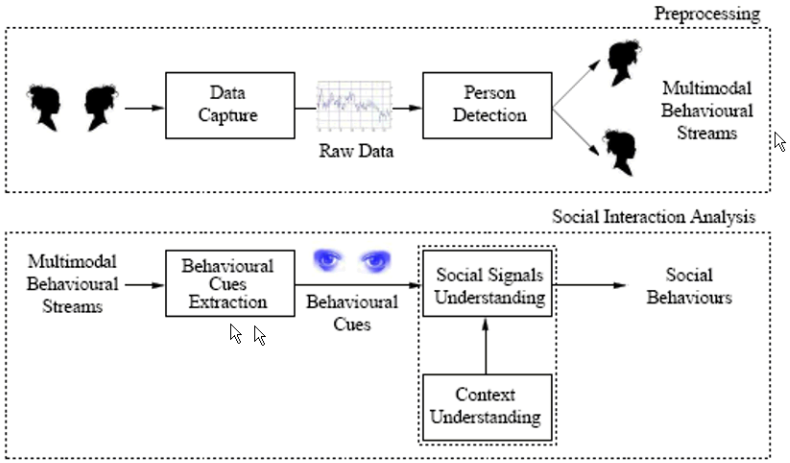

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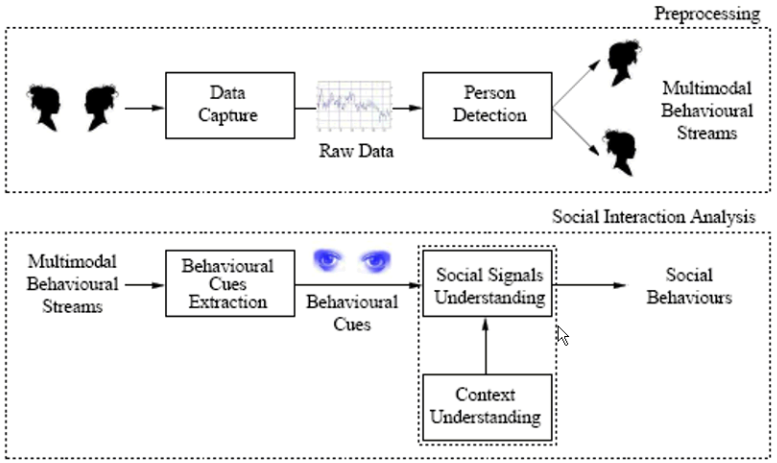

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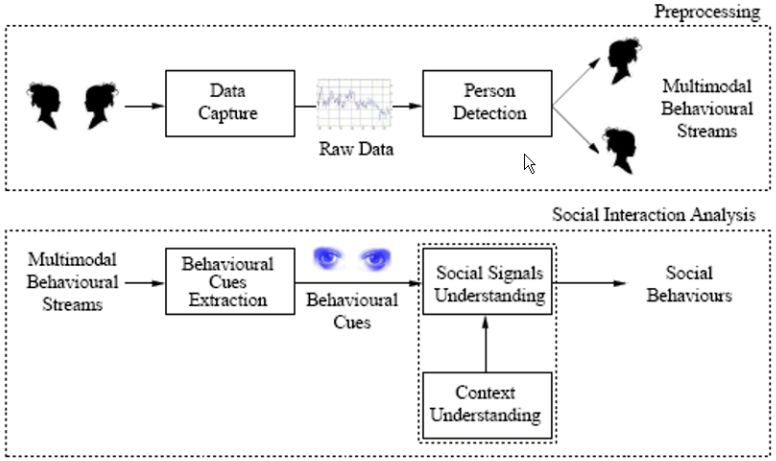

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Data Capture

- Infrastructure sensors: (single or multiple) fixed cameras and / or microphones, Kinect devices,
- Mobile sensors: e.g. in mobile phones: GPS, accelerometer, gyroscopes, eye tracker glasses, pulse-meters, EEG devices, etc.
- Issues:
  - Privacy + scientific ethics („principle of informed consent“)
  - passiveness / unobtrousiveness of sensors

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Person Detection from Audio

- Segmentation into speech / non-speech: (continued)
  -- Use (several) trained binary classifier(s)
  to distinguish between speech and non speech
  on the computed features
- Detection of speaker transitions:
  --split the speech parts into segments (length: e.g. 2-3 seconds)
  --decide with statistical methods, whether
  two segments belong to the same speaker
  (e.g. model each segment with Gaussian,
  use symm. KL-divergence to compute “difference”
  between Gaussians) or
  whether one interval contains one or two speakers
  (e.g. is better modeled by one or two Gaussians, decided
  using likelihood ratio-tests)

Person Detection from Audio

“Speaker Diarization / Segmentation“: given multi-party audio data (possibly with background noise):
→ who talks when?

- Typically 3 steps:
  --segmentation into speech / non-speech
  --detection of speaker transitions
  --clustering of speaker segments (+ classification of speaker)
- Segmentation into speech / non-speech:
  -- Generate features:
  ++ digital signal (pre-) processing
  (involving e.g. sub-division signal into overlapping samples of
  typically several ms, Fourier-transform etc.)
  ++ MEL filters → MEL cepstrum coefficients
  ++ Further Fourier- and other transformations
  ++ additional features: zero-crossing rates, energy statistics etc.