

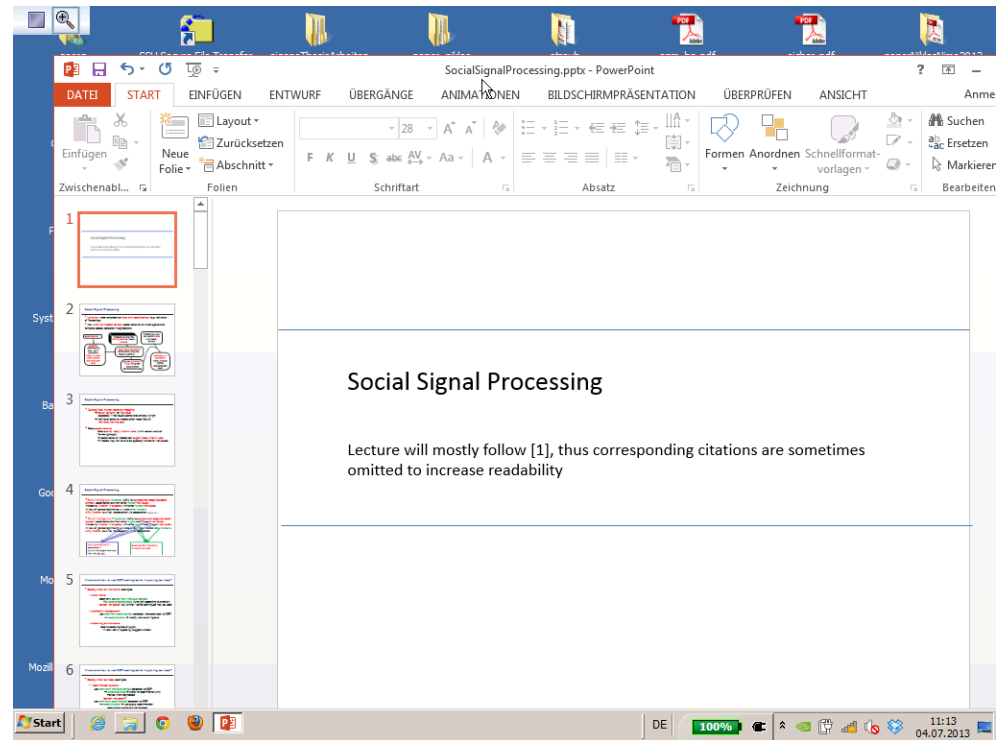
## Script generated by TTT

Title: profile1 (04.07.2013)

Date: Thu Jul 04 11:13:44 CEST 2013

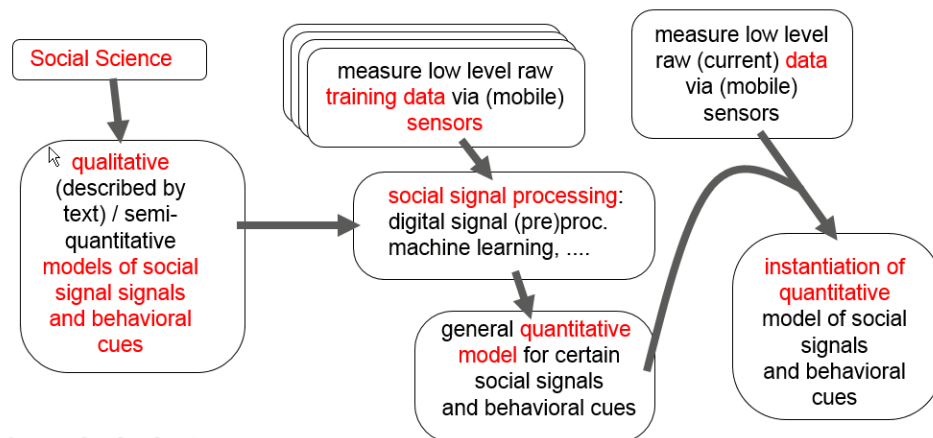
Duration: 93:16 min

Pages: 30



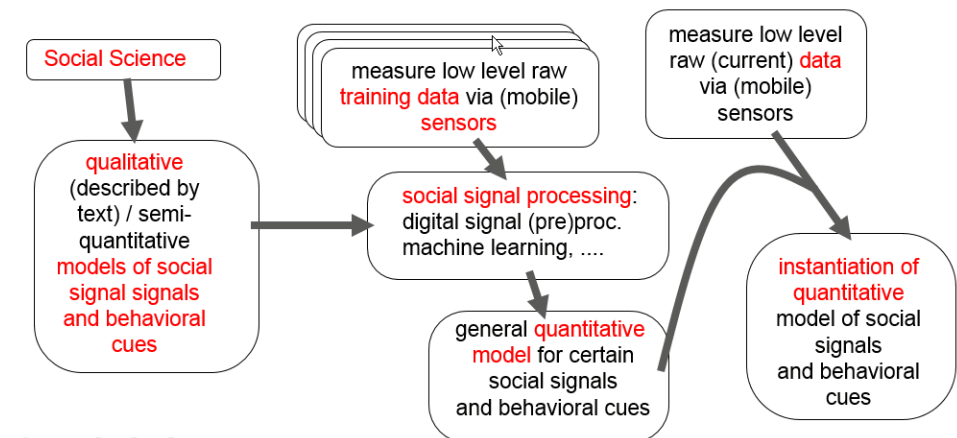
## Social Signal Processing

- **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

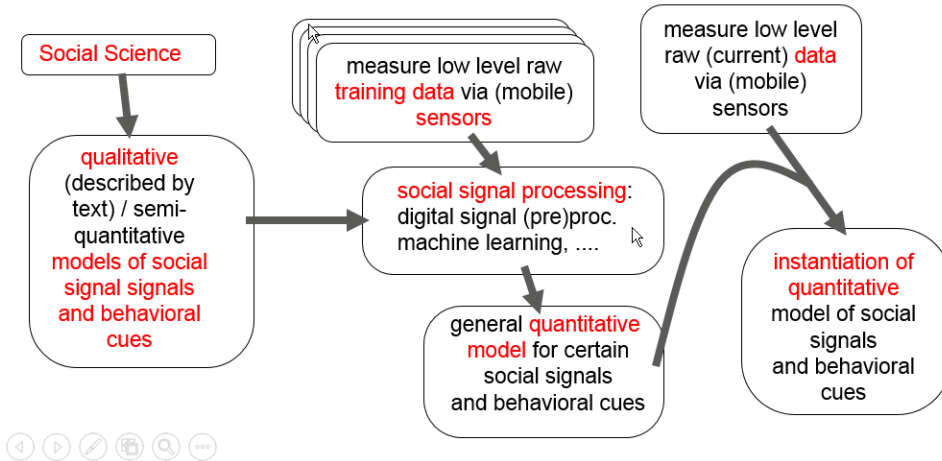
- **Up to now:** most emphasis on **long term social context** (e.g. networks of friendships)
- Now: **short term social context:** social behavior on small spatial and temporal scales: detection + applications





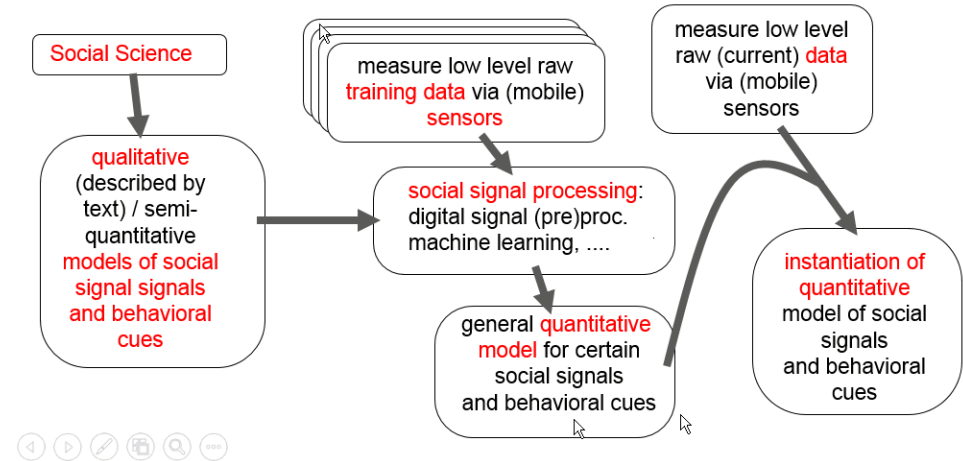
## Social Signal Processing

- **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



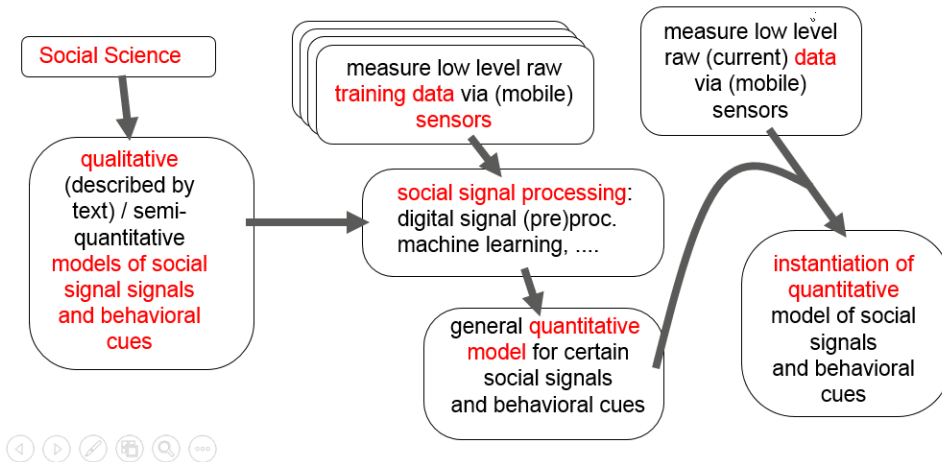
## Social Signal Processing

- **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



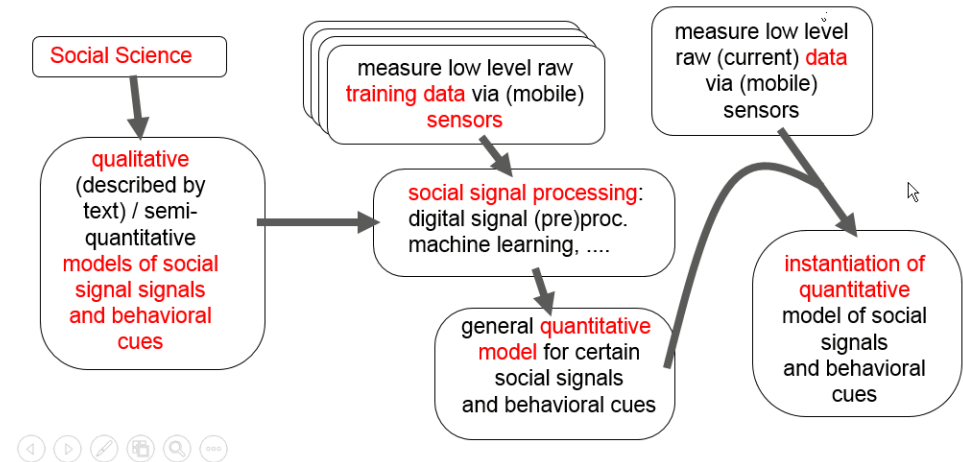
## Social Signal Processing

- **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

- **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

- General field: Human behavior modeling
  - lots of „options“ for individual especially if individual's behavioral entropy is high
  - individual behavior models often need (lots of) individual training data
- Basic social behavior
  - follows strict, nearly uniform rules (within certain cultural frames (groups))
  - social behavior models can exploit these uniform rules
  - models may not have to be specially trained for individuals



## Social Signal Processing

- General field: Human behavior modeling
  - lots of „options“ for individual especially if individual's behavioral entropy is high
  - individual behavior models often need (lots of) individual training data
- Basic social behavior
  - follows strict, nearly uniform rules (within certain cultural frames (groups))
  - social behavior models can exploit these uniform rules
  - models may not have to be specially trained for individuals



## Social Signal Processing

- General field: Human behavior modeling
  - lots of „options“ for individual especially if individual's behavioral entropy is high
  - individual behavior models often need (lots of) individual training data
- Basic social behavior
  - follows strict, nearly uniform rules (within certain cultural frames (groups))
  - social behavior models can exploit these uniform rules
  - models may not have to be specially trained for individuals



## Social Signal Processing

- General field: Human behavior modeling
  - lots of „options“ for individual especially if individual's behavioral entropy is high
  - individual behavior models often need (lots of) individual training data
- Basic social behavior
  - follows strict, nearly uniform rules (within certain cultural frames (groups))
  - social behavior models can exploit these uniform rules
  - models may not have to be specially trained for individuals





## Social Signal Processing

- **General field: Human behavior modeling**
  - lots of „options“ for individual especially if individual's behavioral entropy is high
  - individual behavior models often need (lots of) **individual training data**
- **Basic social behavior**
  - follows **strict, nearly uniform rules** (within certain cultural frames (groups))
  - social behavior models can **exploit these uniform rules**
  - models may not have to be specially trained for individuals



## 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



## 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



## 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 Signals / Social Behavior:** Expressing attitude towards elements of a social setting:

- Mirroring (if mutual attraction)
- aggressive turn taking behavior
- 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)



## Social Signals and Behavioral Cues

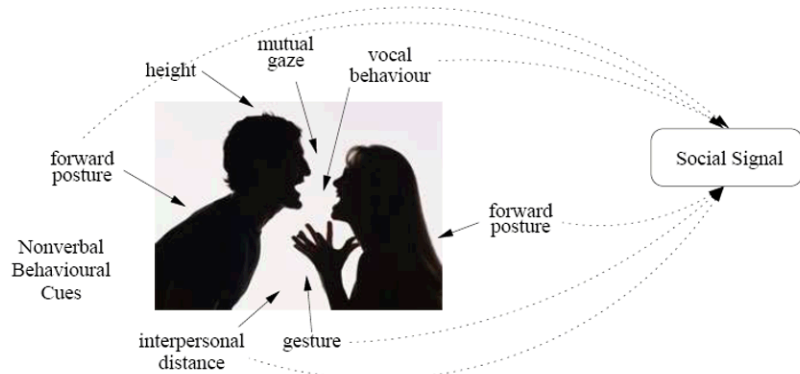


Fig. 1. Behavioural cues and social signals. Multiple behavioural cues (vocal behaviour, posture, mutual gaze, interpersonal distance, etc.) combine to produce a social signal (in this case aggressivity or disagreement) that is evident even if the picture shows only the silhouettes of the individuals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

[1]



## Social Signals and Behavioral Cues

• **Examples of Social Signals / Social Behavior:** Expressing attitude towards elements of a social setting:

- Mirroring (if mutual attraction)
- aggressive turn taking behavior
- 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)



## Social Signals, Social Behavior, Behavioral Cues

- (Social) **Behavioral Cues:** „composed of“ / manifested via (series of / parallel / overlapping / single ...) time-series of perceivable or measurable **physiological activity**. (neglecting content of communication)
- **Social Signals** (conscious or unconscious): „composed of“ / manifested via (series of / parallel / overlapping / single ...) **Behavioral Cues**.
- **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 %)**) → hard to analyze social relations, interactions etc. from content only





## 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:**

- intensional: have direct verbal translation, people are aware of
  - *affective/attitudinal/cognitive states* (e.g. fear, joy, stress, disagreement, ambivalence and inattention),
  - *emblems* (culture-specific interactive signals like wink or thumbs up),
- adaptors : involuntary, habitual, honest (e.g. folding arms, crossing away legs)
  - *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
- regulate turn taking and other conversational aspects
  - *regulators* (conversational mediators such as the exchange of a look, palm pointing, head nods and smiles).

[1]



## 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:**

- intensional: have direct verbal translation, people are aware of
  - *affective/attitudinal/cognitive states* (e.g. fear, joy, stress, disagreement, ambivalence and inattention),
  - *emblems* (culture-specific interactive signals like wink or thumbs up),
- adaptors : involuntary, habitual, honest (e.g. folding arms, crossing away legs)
  - *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
- regulate turn taking and other conversational aspects
  - *regulators* (conversational mediators such as the exchange of a look, palm pointing, head nods and smiles).

[1]



## 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:**

- intensional: have direct verbal translation, people are aware of
  - *affective/attitudinal/cognitive states* (e.g. fear, joy, stress, disagreement, ambivalence and inattention),
  - *emblems* (culture-specific interactive signals like wink or thumbs up),
- adaptors : involuntary, habitual, honest (e.g. folding arms, crossing away legs)
  - *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
- regulate turn taking and other conversational aspects
  - *regulators* (conversational mediators such as the exchange of a look, palm pointing, head nods and smiles).

[1]



## Social Signals, Social Behavior, Behavioral Cues

- **Table of Behavioral cues:**

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

(\*) mutual trust vs. distrust

[1]



## Physical Appearance

### • „Implicit“ „Behavioral“ Cues / Social Signals

- natural characteristics (e.g. body shape)
- artificial characteristics (e.g. make up)
- Especially important for attractiveness → halo effect (“what is beautiful is good”);
- other example of effect mechanism: height, somatotype → power, influence, strength

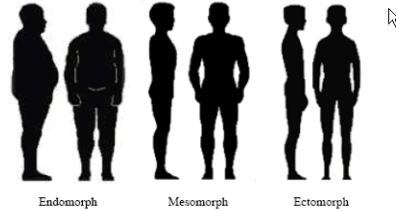


Fig. 2. Somatotypes. The figure shows the three body shapes that tend to elicit the perception of specific personality traits. [1]



## 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.), regulators (conversational mediators like nod and gaze exchange) illustrators (accompanying speech (e.g. raised eyebrows))



## 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: **adaptors**: 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, rhythmically moving legs etc.)



## 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







## Space and Environment

### Interpersonal distances (Hall):

#### Proxemics:

- [0, 0.5] m : intimate zone
- [0.5, 1.2] m : casual-personal zone
- [1.0, 2.0] m : socio-consultative zone
- [2.0, ∞] m : public zone

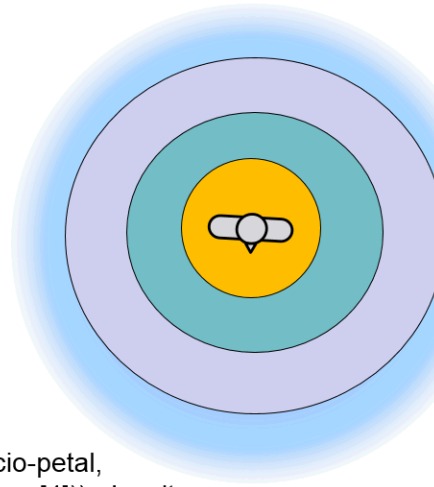
#### Other influences

##### social context:

architectural environment (socio-petal, socio-fugal forces (Watson) (see [4])), density, gender, etc.

##### individual context:

culture, age, self-esteem, disabilities,



## 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 (e.g. MFCC)
- ++ Further Fourier- and other transformations
- ++ additional features: zero-crossing rates, energy statistics etc.

