

# Multiple knowledge categorising behavioural states and communication attempts in people with profound intellectual and multiple disabilities.

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Matej Cigale, Mitja Luštrek  
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Department of intelligent systems, Jožef Stefan Institute, Ljubljana

# Outline

Section 1: Introduction, motivation and problem definition

Section 2: Sources of knowledge

Section 3: Overview of the solutions

Section 4: Custom methods that incorporate expert knowledge

Section 5: Further work

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# People with PIMD

- Profound intellectual and multiple disabilities
- Other possible disabilities such as motor or sensorial impairments
- Often coupled with other health issues
- Heavily reliant on caregivers
- Each individual is unique with different abilities and signals



## Goals of the work

- Allow people with PIMD to access digital services to enrich their life
- Use non-symbolic communication(NSC) signals to detect:
  - inner states
  - communication attempts
- Use with context to propose actions that improve mental state
  - Liked and disliked people
  - Suggest adding or removing an
  - Change the environment to suit the needs of the person

# Problem definition



# Problem definition



Q: How does she feel?  
A: I can see her **smiling**



# Problem definition



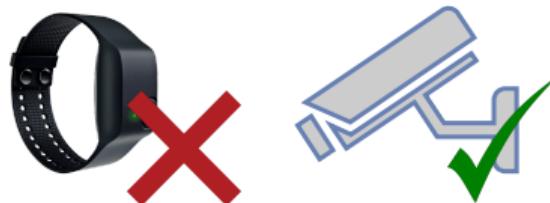
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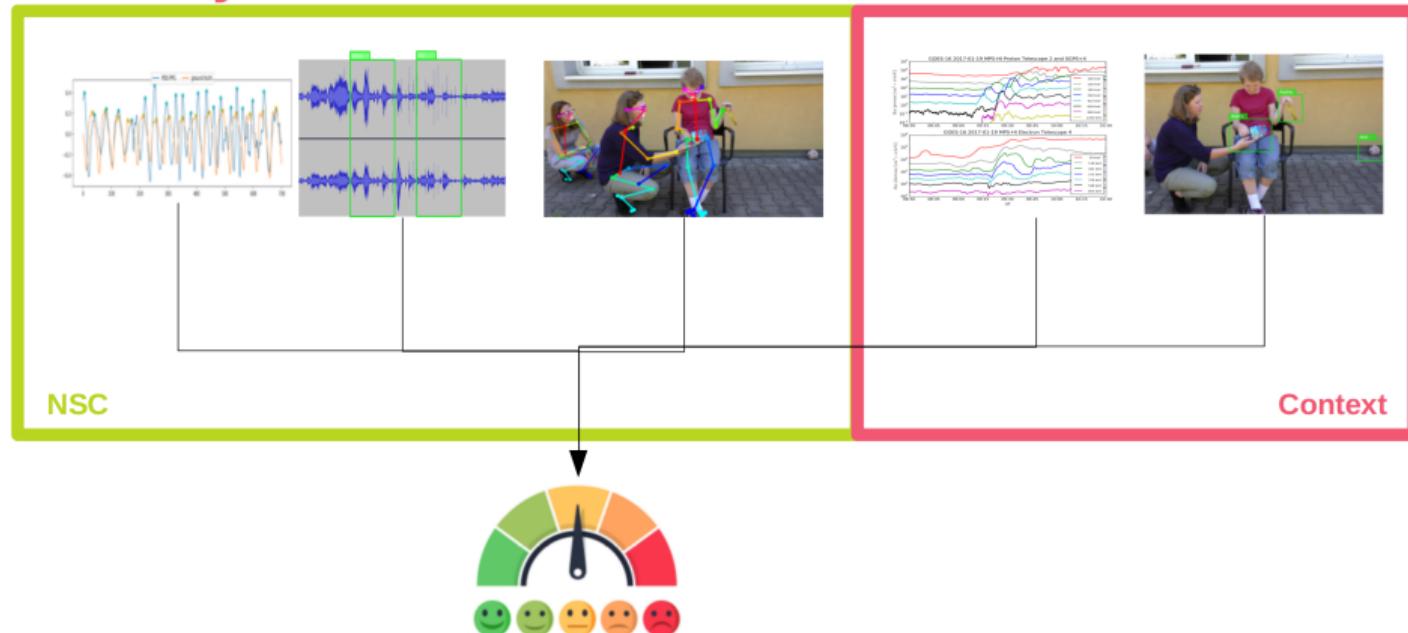
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# Non-symbolic communication and Context



# Data collection

- Annotated data
- Expert knowledge from caregivers

2.3-corners of mouth	because of screaming
3.11-Specific Moves	showing teeth
5.2-female caregivers	
5.5-End-user acts	
5.8-Other noises	bottle sizzling
A.1 Comment	bottle sizzling
A.2 Demand	
A.3 Protest	
B.1 Pleasure	
B.2 Displeasure	

2.2.	Appearance of Eyes	Appearance of Pleasure		
Cross the words that best describe the appearance of eyes		<input checked="" type="checkbox"/> good eye contact	<input type="checkbox"/> little eye contact	<input type="checkbox"/> avoiding eye contact
		<input type="checkbox"/> closed eyes	<input checked="" type="checkbox"/> staring	<input type="checkbox"/> sleepy eyes
		<input checked="" type="checkbox"/> "smiling"	<input type="checkbox"/> winking	<input type="checkbox"/> vacant
		<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/> eyebrow
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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## Decision support system approaches

- Up till now we evaluated several different possible approaches:
  - Several standard ML approaches
  - Unique non-symbolic communication signals model
  - Valence derived inner state model
  - Decision support system based on expert knowledge
- Augmenting ML with expert knowledge

## Standard ML approaches

- Several methods were tested
  - nearest neighbors, linear SVM, RBF SVM, Gaussian process, decision tree, random forest, neural net, AdaBoost, naive Bayes, QDA
- The decision trees provide the best results
- We would like to make use of expert knowledge and perhaps even have access to the model and tweak it if the experts say that it does not make sense

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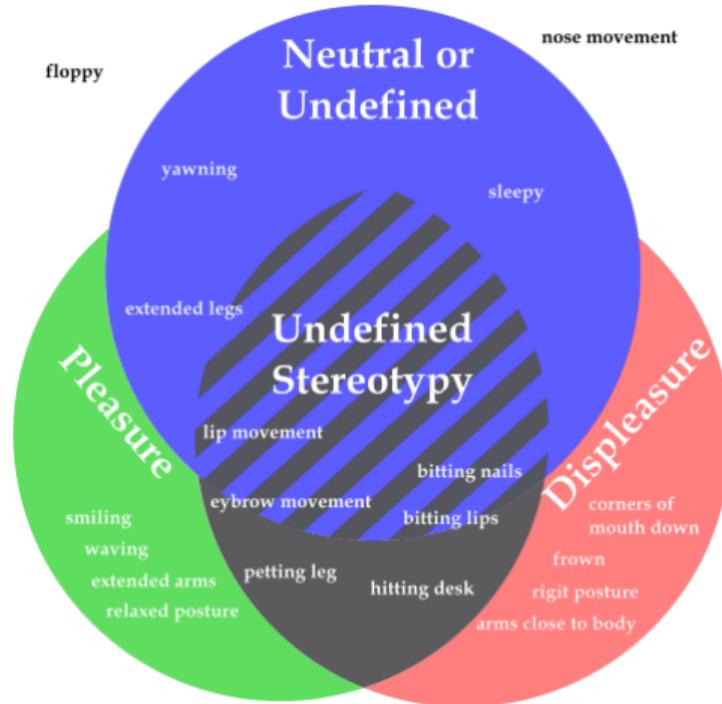
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# Unique non-symbolic communication

- Try to extract the NSC that is unique to each inner state and does not happen in any other situation
- To decide pleasure we check if any there exists a NSC that is defined as pleasure and is detected

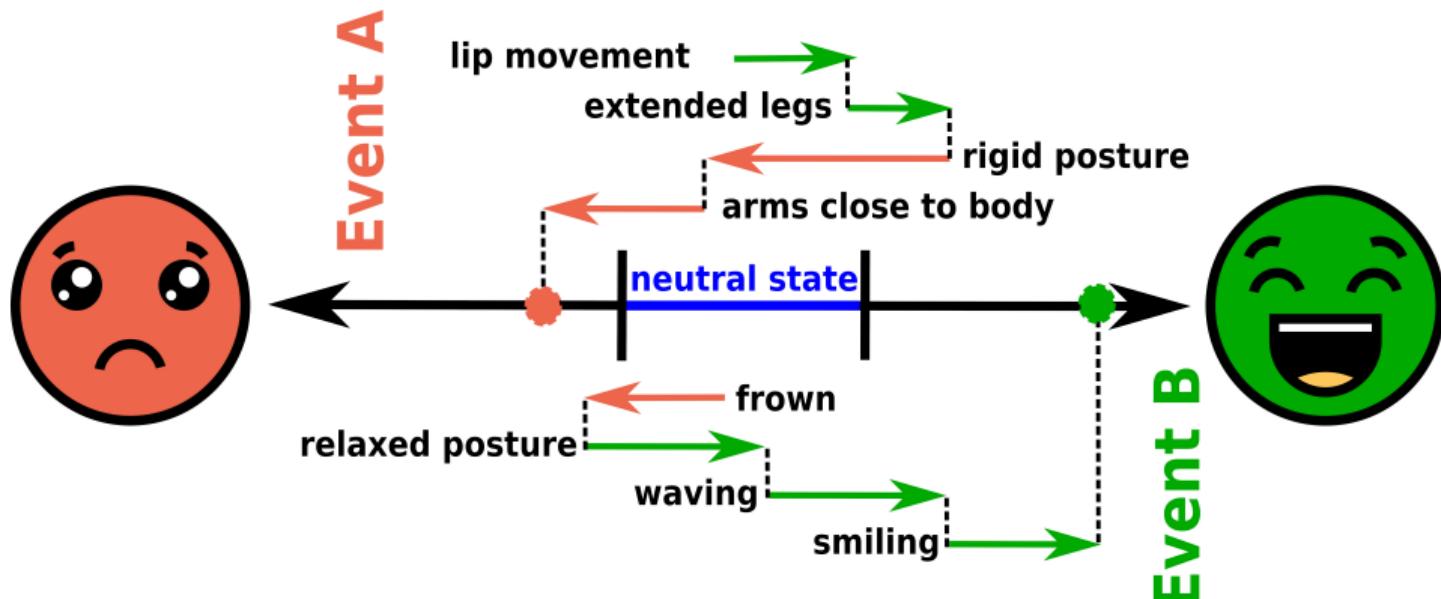


### The Unique Non Verbal Signals Method



## Valence method

- Calculate the valence score of a NSC, then decide based on the sum of expressed NSC what inner state is most
- This method is expected to perform better with more observations



### The Valence Method



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- People and objects can be good indicators of inner state
  - The dataset at this time small
  - Some objects/people are session specific
  - Hard to argue causality
- The system might perform better if historical information is taken into account
- Working with the data from the recognizers needs to be validated
- Specialised ontology to aid reasoning about context in development