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

Matej Cigale, Mitja Luštrek
Rome 13th - 15th of November

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
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
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

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

She is smiling; she must be happy.
She is smiling, she must be happy
Q: How does she feel?
A: I can see her smiling
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
Non-symbolic communication and Context
### Data collection

- Annotated data
- Expert knowledge from caregivers

#### 2.2. Appearance of Eyes

<table>
<thead>
<tr>
<th>Appearance of Pleasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>✗ good eye contact</td>
</tr>
<tr>
<td>❏ little eye contact</td>
</tr>
<tr>
<td>❏ avoiding eye contact</td>
</tr>
<tr>
<td>❏ closed eyes</td>
</tr>
<tr>
<td>❏ staring</td>
</tr>
<tr>
<td>❏ sleepy eyes</td>
</tr>
<tr>
<td>❏ &quot;smiling&quot;</td>
</tr>
<tr>
<td>❏ winking</td>
</tr>
<tr>
<td>❏ vacant</td>
</tr>
<tr>
<td>❏ eyebrow</td>
</tr>
</tbody>
</table>

Cross the words that best describe the appearance of eyes.
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
• 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
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
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
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.
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
Further work

- 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