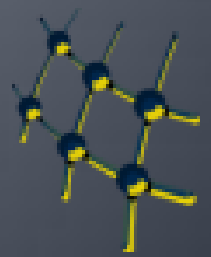
Toward Social Cognition in Robotics: Extracting and Internalizing Meaning from Perception

Jesús Martínez-Gómez, Rebeca Marfil, Luis V. Calderita, Juan Pedro Bandera, Luis J. Manso, Antonio Bandera, Adrián Romero-Garcés and Pablo Bustos



Outline

- Motivation
- The Adapta Scenario
- The RoboCog Architecture
- Experiments and Results

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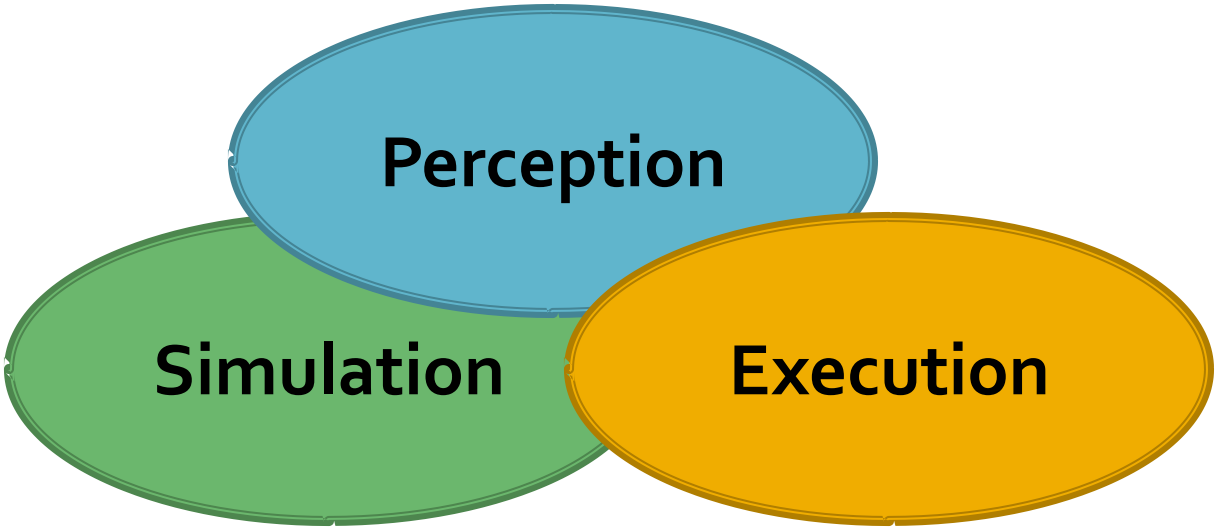
Motivation

- Lot of sources of information
  - Visual Images
  - Range Images
  - Sounds
  - Tactile sensors
  - Laser

… but how to internalize this information?

Motivation

- The Problem → Adapta Scenario
- The proposed solution → RoboCog
  - Based on human plans making
  - Different levels of abstraction



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The Adapta Scenario

- Goal: social robot as a vendor
  - It waits in a starting area
  - Moves to the first person in the place
  - Classifies gender and age of the candidate
  - Selects the most suitable theme for a conversation
  - Convinces for moving to a panel
  - Takes people to the panel

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People tracking and detection

Navigation

Perception and classification

Multimodal HRI (ASR and Speech generation)

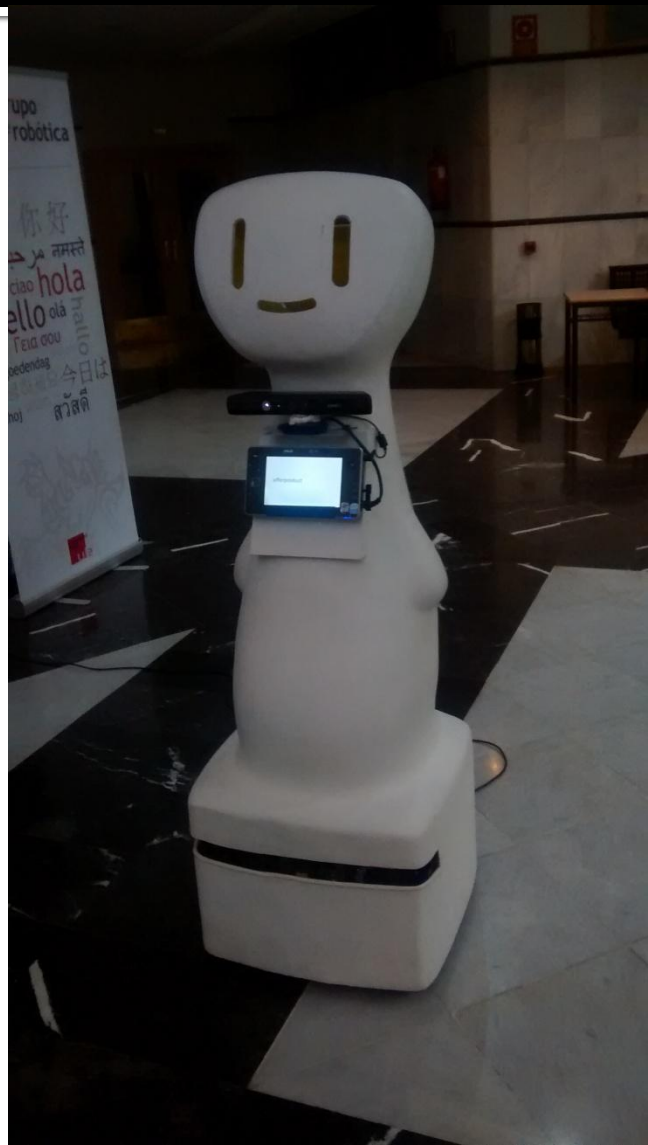
Obstacle Avoidance

Planning

Battery Management

The Adapta Scenario

- Sensors
  - Microsoft Kinect
    - Microphone
    - Visual Camera
    - Range Camera
  - Laser
- Actuators
  - Speakers
  - Wheels
  - Facial Expressions



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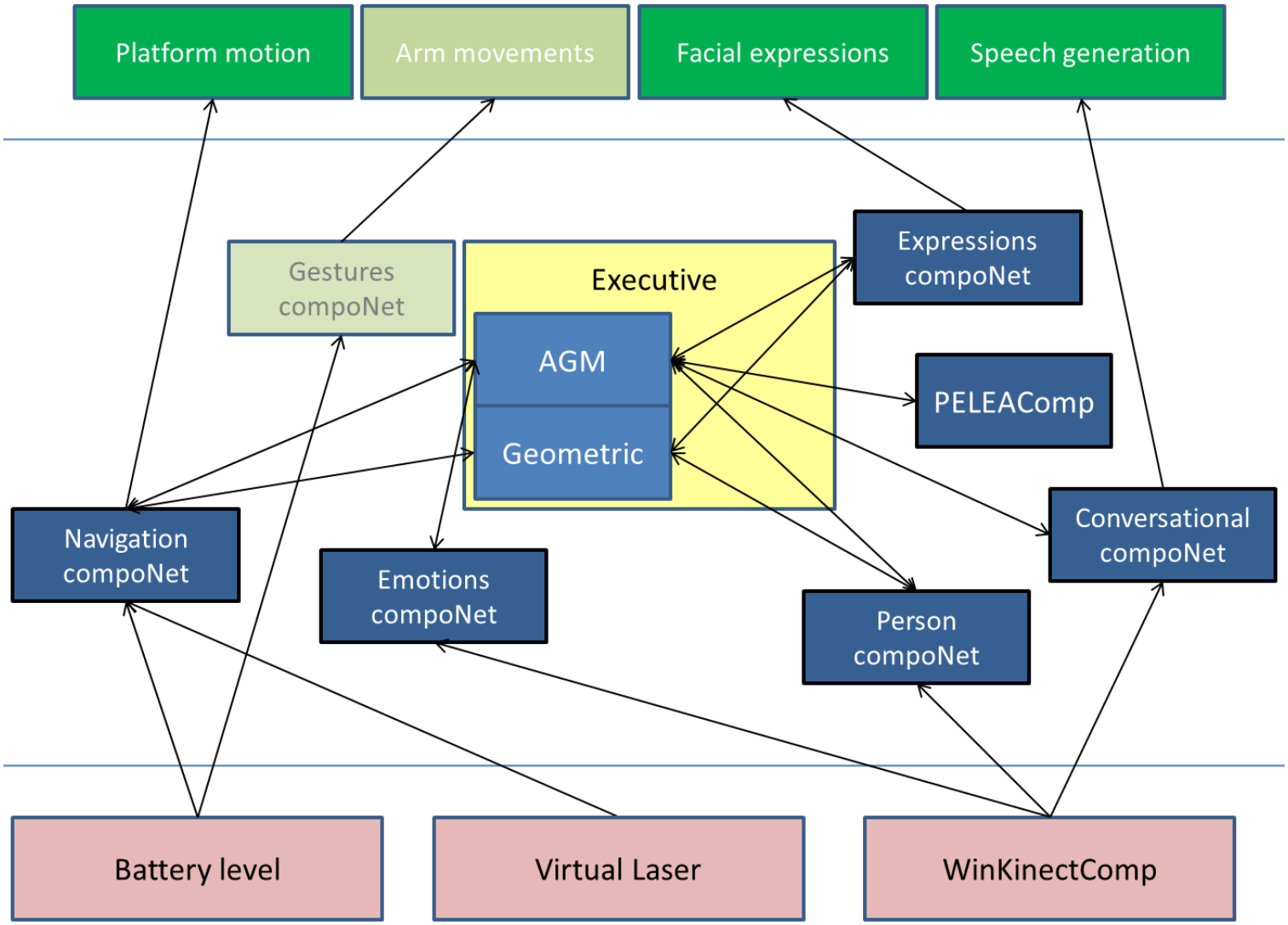
RoboCog

- Common motor representation for
  - Perception
  - Simulation
  - Execution
- Inner representation of the world
  - Hierarchical → From fine-grain to symbolic level
- Multi-platform through Ice

RoboCog


Platform motion
Arm movements
Facial expressions
Speech generation
Gestures compoNet
Executive
AGM
Geometric
Expressions compoNet
PELEAComp
Navigation compoNet
Emotions compoNet
Person compoNet
Conversational compoNet
Battery level
Virtual Laser
WinKinectComp

RoboCog

- Task oriented modules → compoNets
- Symbolic level → Graph representation
- Geometric level → Inner Model
- Decision Making → Pelea CompoNet
- Information integration → Agents
  - The Executive evaluates the feasibility of the input information

RoboCog – The WinKinectComp

- Speech Information
  - Text Transcription
- Body Information
  - List of people detected in the scene
- Face Information
  - Position and features of detected faces

RoboCog – Person Componet

- Processes bodies and faces "raw" information
- Focus on the first person
  - → Geometric Information
- People Tracking
  - → Geometric Information
- Age and gender Classification
  - → Symbolic Information

RoboCog – Person Componet

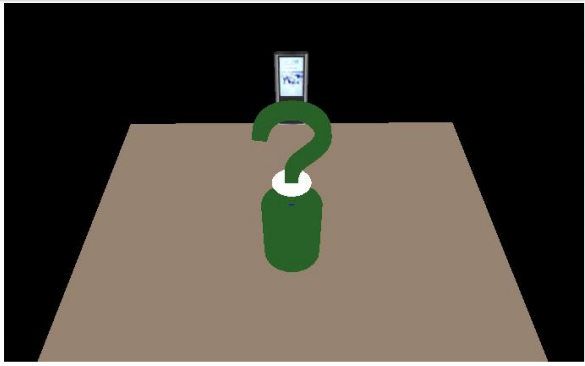
- Information is internalized

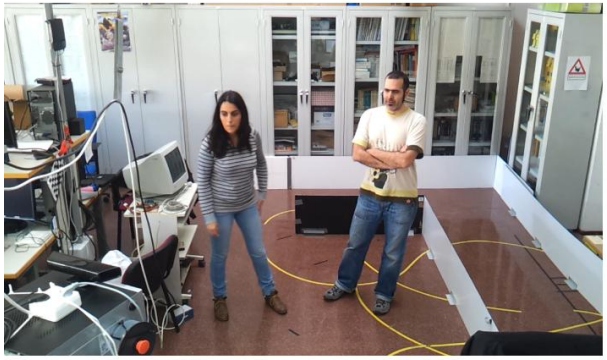
- Geometric:

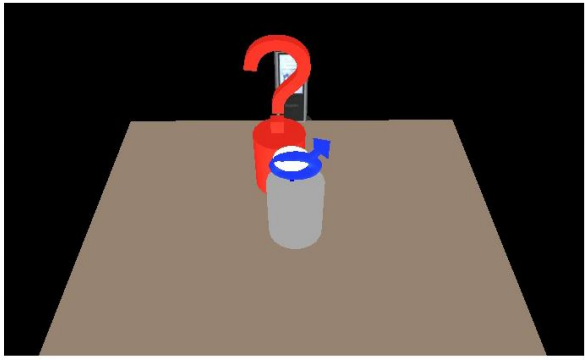
all people position

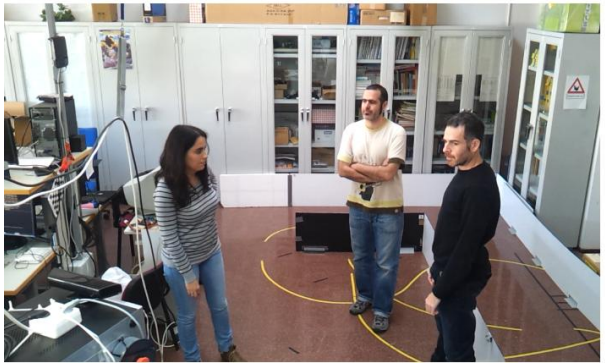
- AGM:

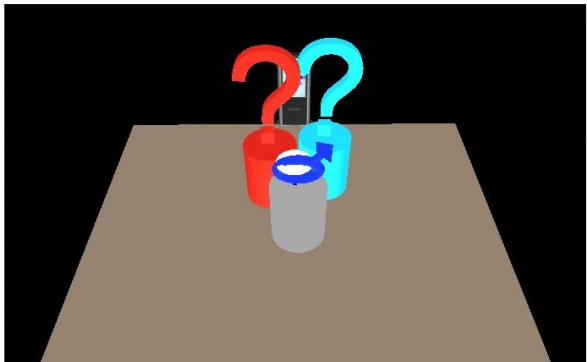
Just the first Person target





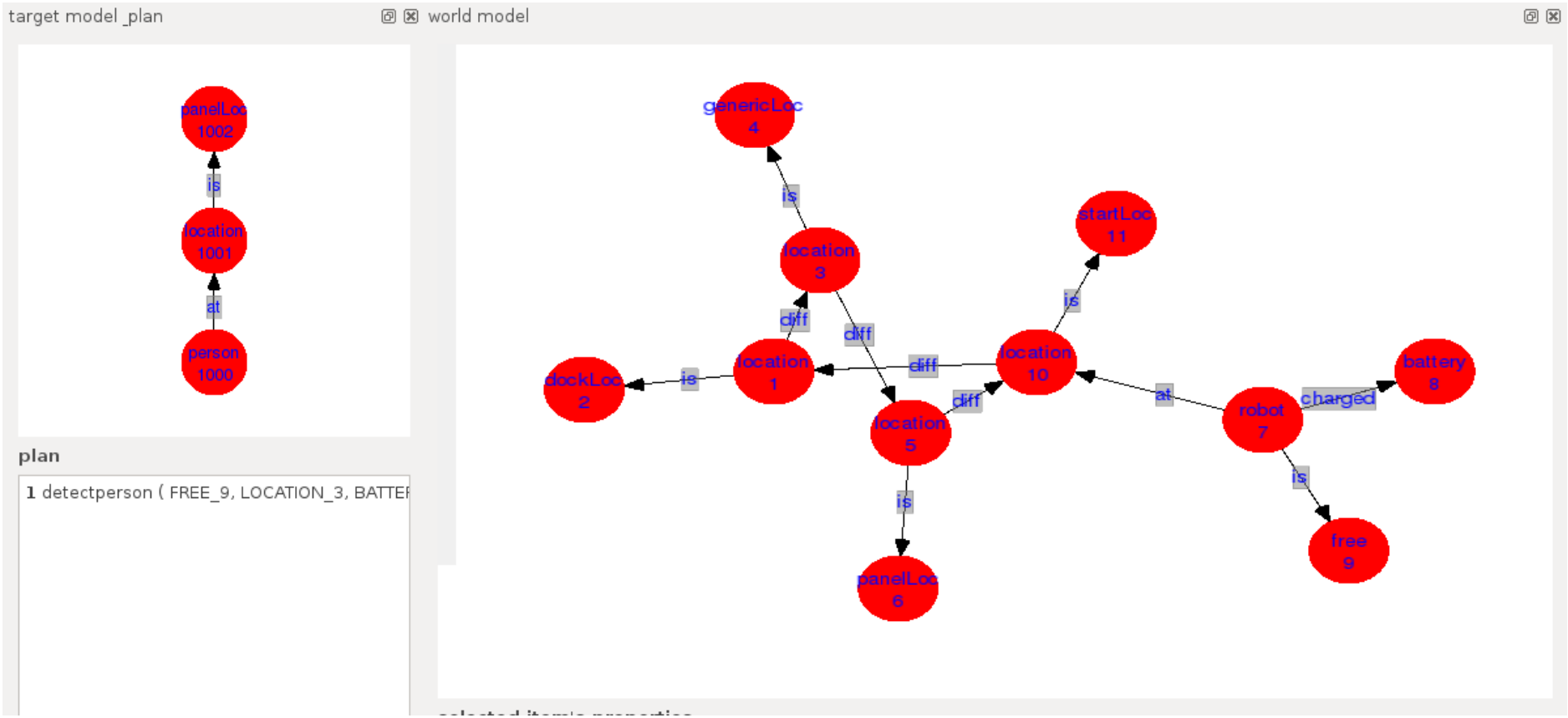






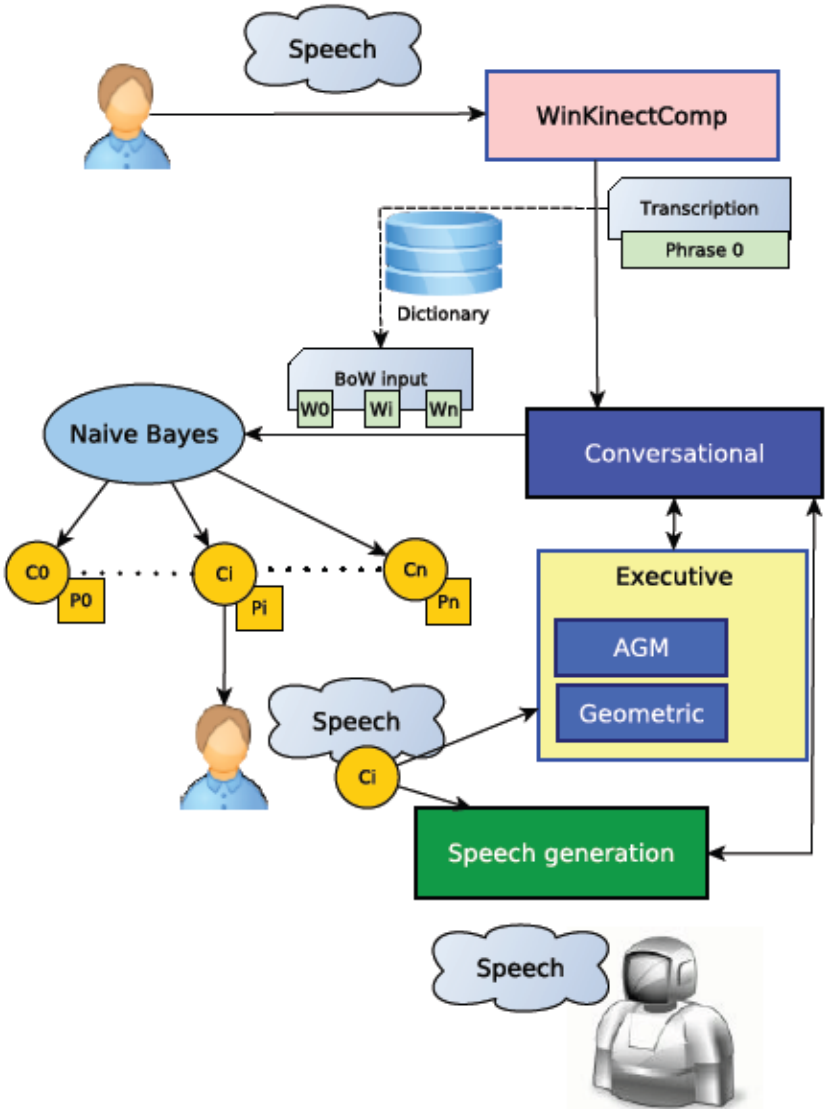
RoboCog – Person Componet

- Symbolic representation → single person



RoboCog – Conversational

- Comprehension
  - Semantic labels
- User oriented conversations
- End of conversation
  - AGM update



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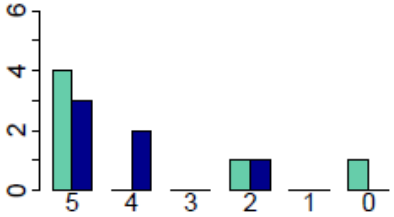
Experiments

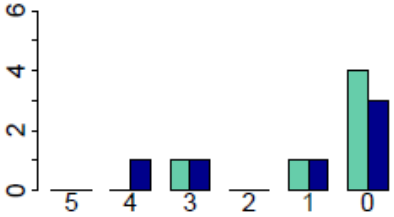
- We followed the method proposed by Joosse et al. BEHAVE II database
- A questionnaire was filled by 12 people
  - 6 people involved in the ADAPTA project
  - 6 people without connections with ADAPTA
- 16 questions related to
  - Navigation, Conversation, Interaction, Sensations, other issues

Experiments

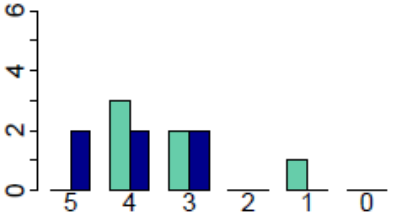
- Results (I)



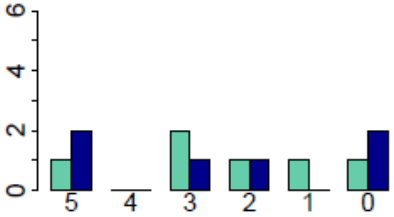
Do you feel safe when the robot approaches you?



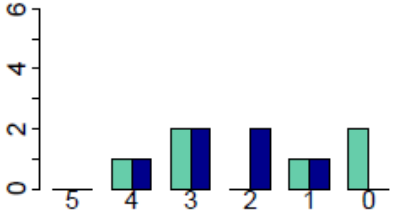
Does the robot invade your personal space?



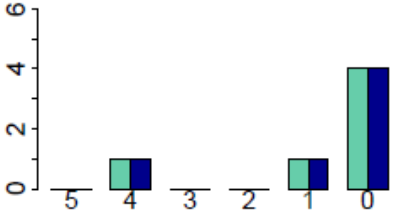
Have you understood what the robot told you?



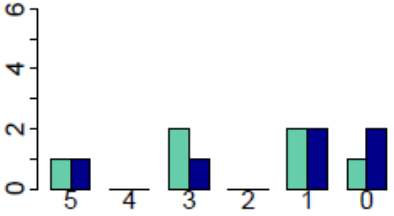
Do you think the robot understood you?



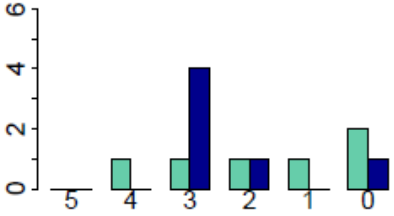
Do you think robot movements are natural?



Have you stepped away from the robot during the interaction, because you feared you could collide?



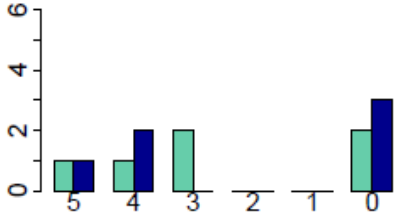
Could you maintain a coherent conversation?



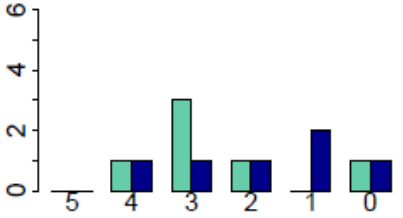
Do you think the robot has a pleasant voice?

Experiments

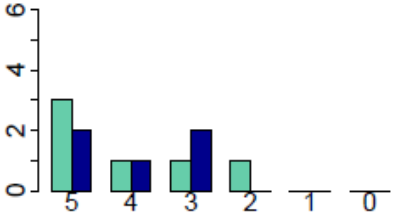
- Results (II)



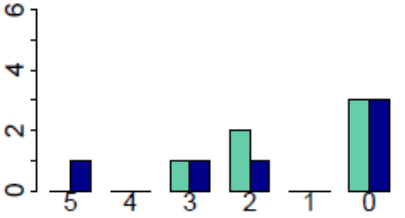
Did the robot get blocked during the interaction?



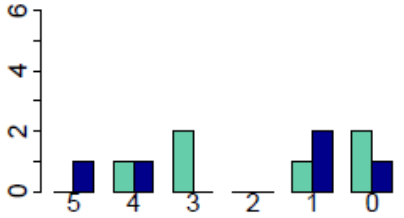
Do you think your interaction with the robot was natural?



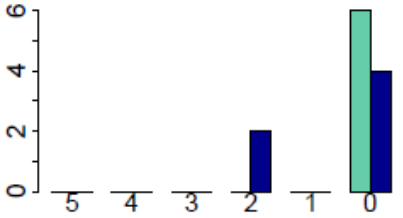
Did you enjoy the experiment?



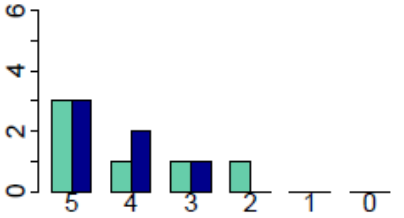
Do you think the experiment was not interesting?



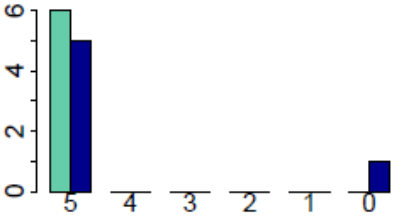
Was the conversation fluent?



Did the robot seem to be controlled by a person?



Would you like to repeat the experiment?



Would you recommend other people to interact with the robot?

Experiments - Conclusions

- Navigation
  - Robot movements are perceived as safe but unnatural
- Conversation
  - Robot voice is understandable but unpleasant
- Interaction
  - Not fluent and too many blocking episodes
  - The robot was truly perceived as autonomous
- General feeling
  - People would like to repeat the experiment

Conclusions

- RoboCog ←→ Adapta Scenario
  - Right Decision: multimodal data is integrated
- Different levels of representation
  - Very useful for future modifications
  - Fast for reactive behaviors
- Simulation-based decision making
  - → Novel and very interesting approach

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