The cognitive architecture of a robotic salesman

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- Agents
- Gualzru, the robot
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Introduction

- Robotic architectures
  - Modules that allow the robot to work
  - Perception, motion, planning, learning…
- Cognitive architectures
  - General-purpose reasoning
  - Problem solving
  - High-level cognitive processes
- Robotic cognitive architectures
  - Integrate high-level simbolic cognitive processes in a robot operating in the real world.

CORTEX

1. Percepts represent objects and their properties
2. Goals are explicitly represented
3. Behaviours are represented by discrete actions and their parameters
4. Processing occur in cognitive cycles

CORTEX: Agent-based robotic cognitive architecture

- **Use a unique dynamic graph to model the reality at different abstraction levels (symbolic and geometric).**
- **Use internal emulation to *imagine*.**

Real tests for a real architecture: Objective

- CORTEX is tested in a real scenario: the ITC-20111030 ADAPTA Project
- Use case: *Gualzru*, the robotic salesman

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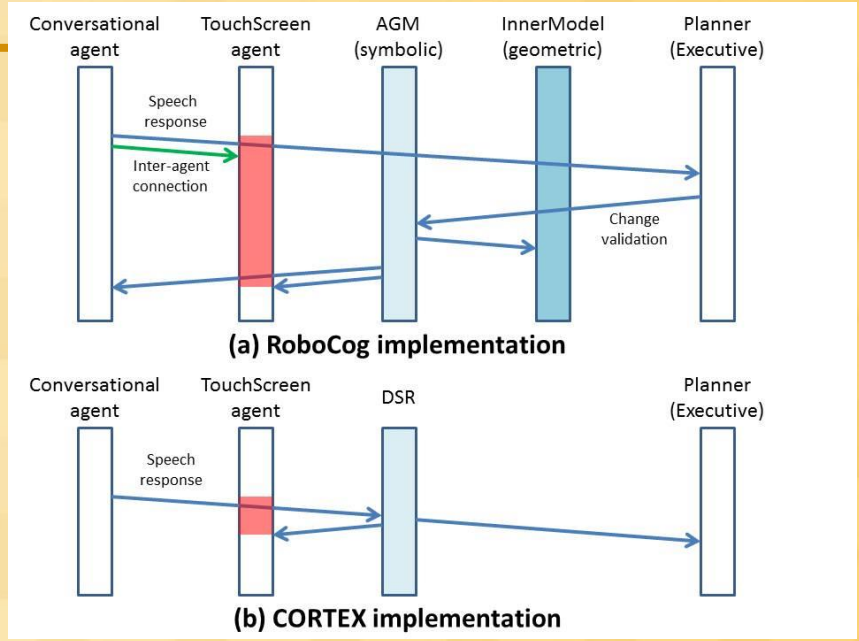
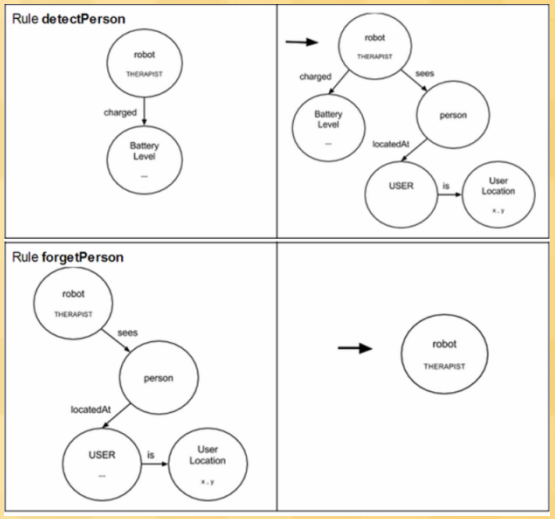
RoboCog vs CORTEX

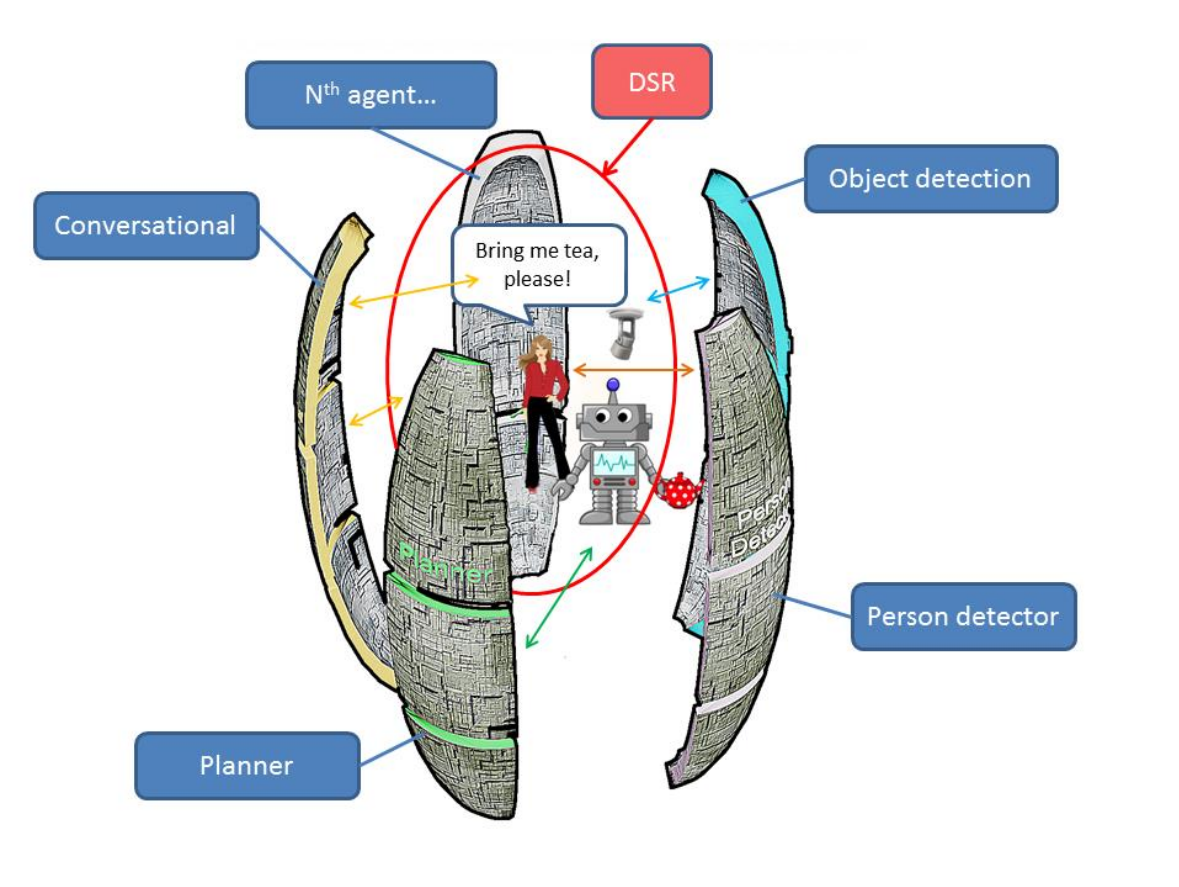
- RoboCog:
  - First implementation of a cognitive architecture
  - World model: Two shared objects (InnerModel, AGM)
  - Changes have to be validated
- CORTEX:
  - Only one object to model the world (DSR)
  - Two types of agent actions (structural and non-structural changes)





CORTEX

- DSR includes symbolic and geometric data
- Agents are synchronized with the DSR and update it
- Planning agents can execute cognitive cycles



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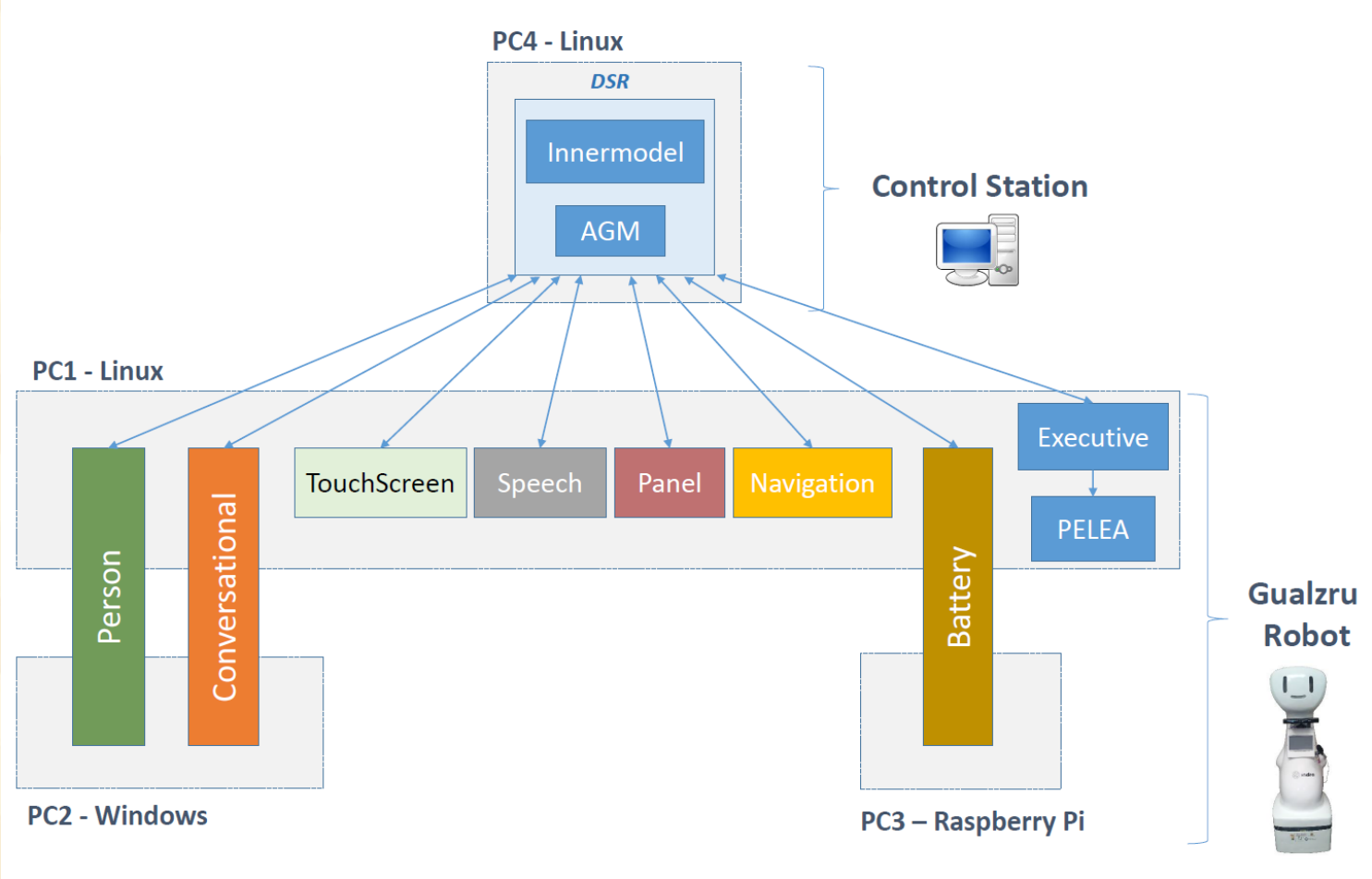
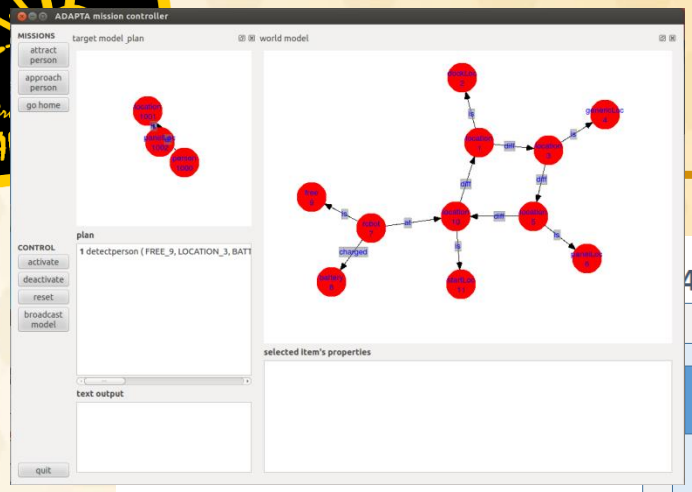
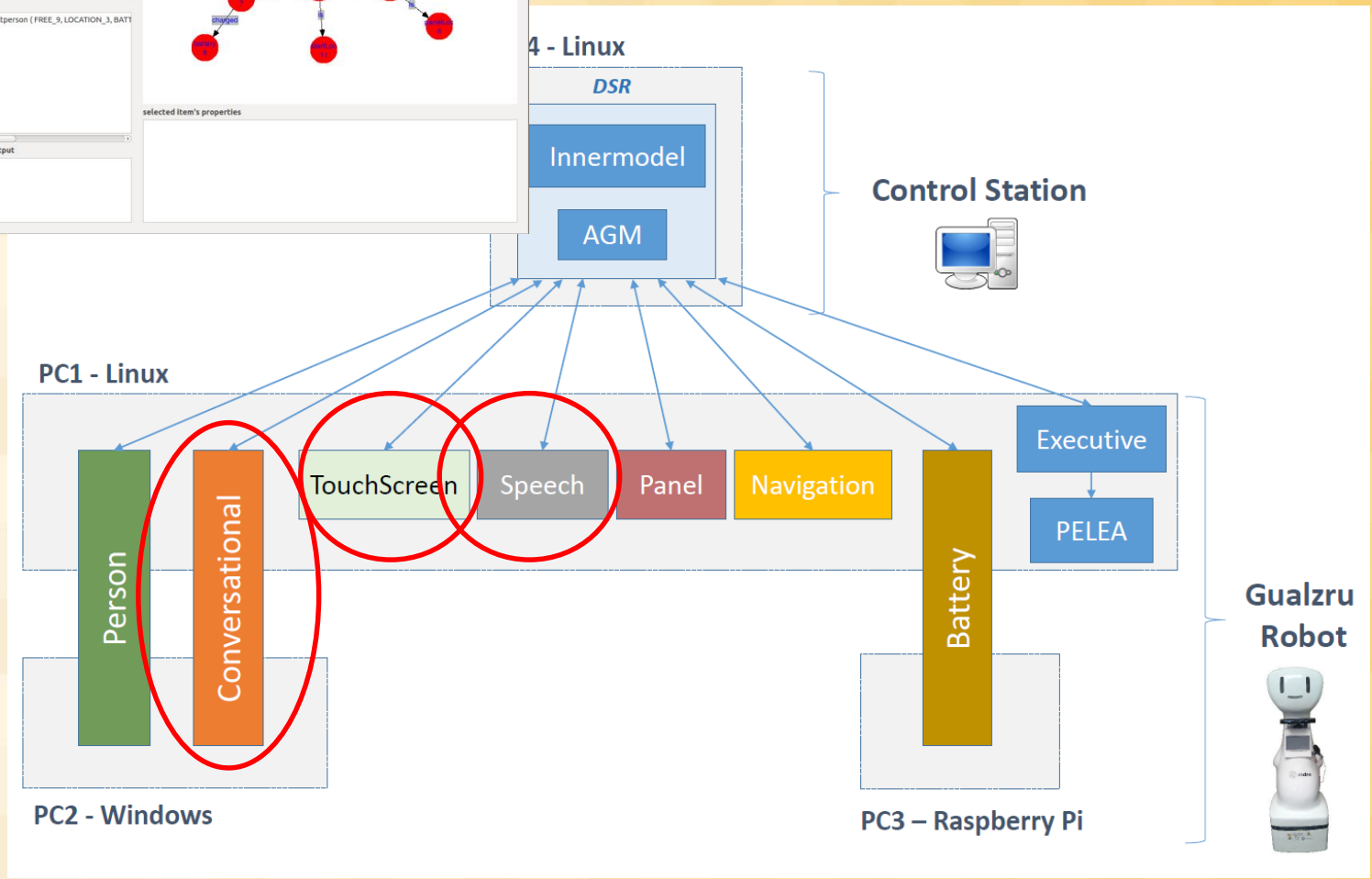
Agents for Gualzru



nts for Gualzru





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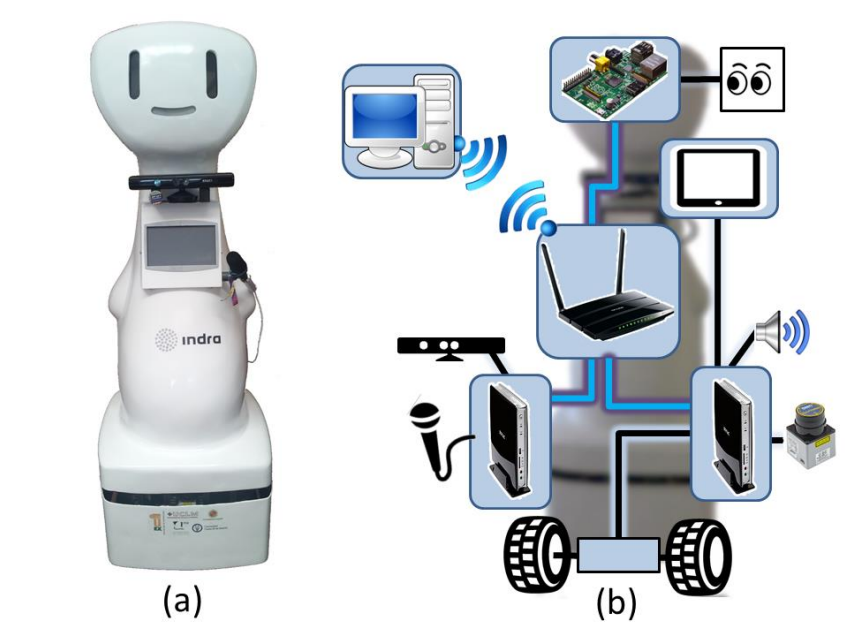
Gualzru

Features:

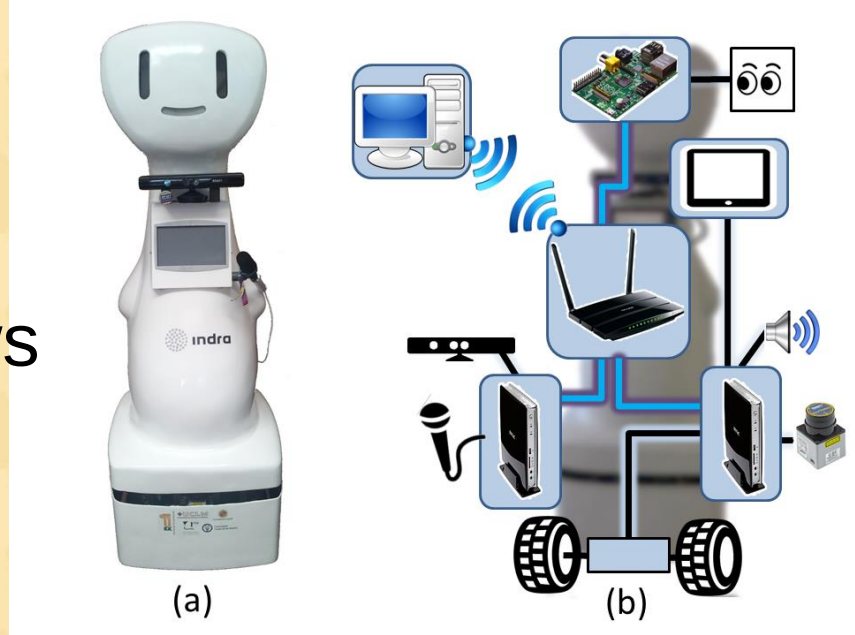
- Differential base
- RGB-D perception
- Laser
- Directional microphone
- Speakers
- Touch panel
- Friendly and safe shape
- Wifi connection



Gualzru

Main components:

- Router
- Embedded PC 1: Linux
  - Most agents
- Embedded PC 2: Windows
  - Kinect + Micro
- External PC:
  - Interface agents
- Raspberry Pi2:
  - Small stuff



Up to 20 software components working together!

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The ADAPTA use case

Final tests: Setup

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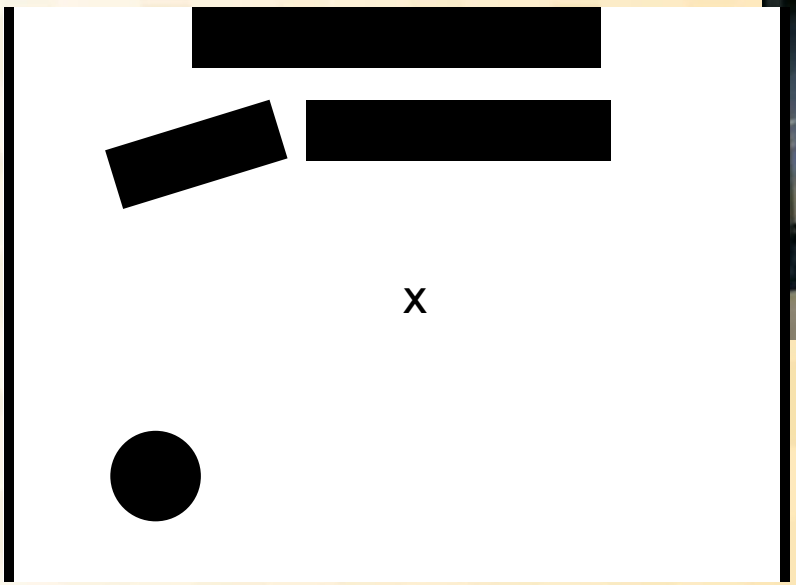
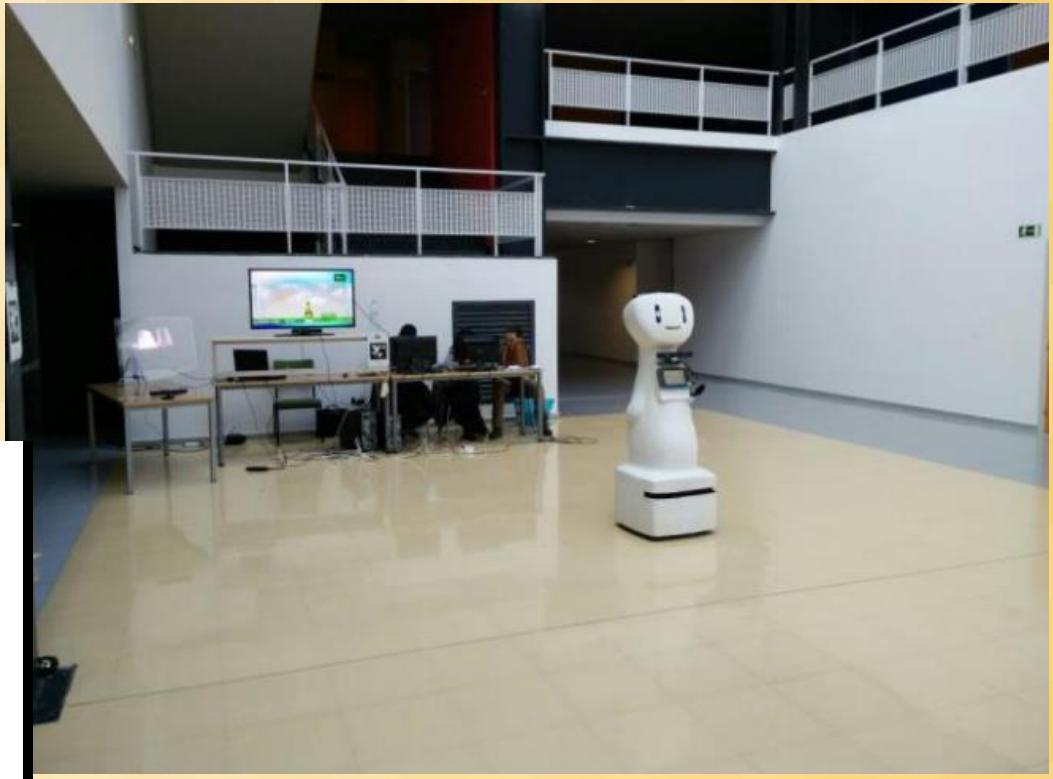
Universidad de Málaga

10m x 8m

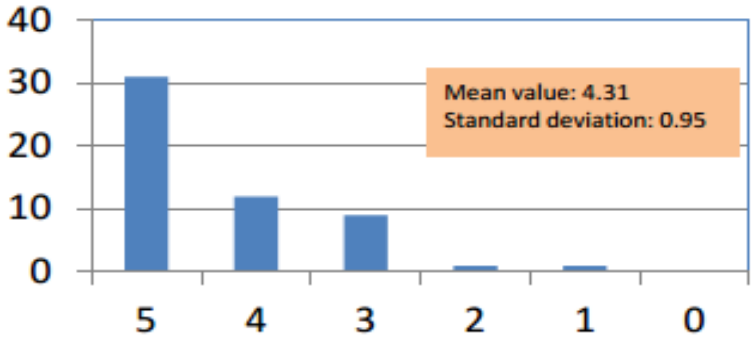




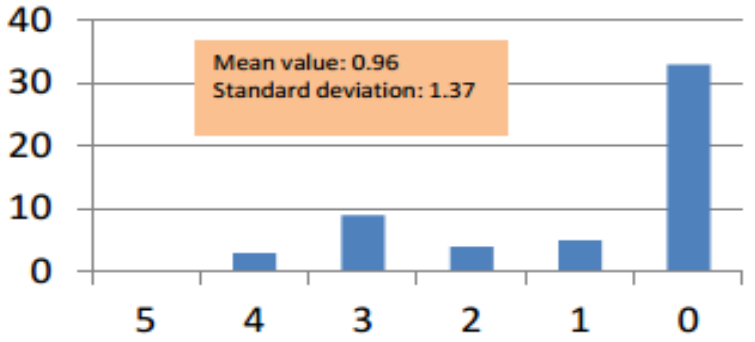
People walk freely through the test area

Final tests: Results

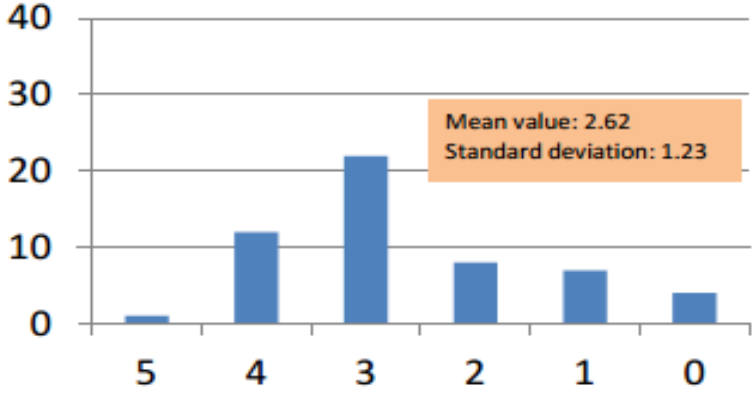
1.1
Do you feel safe when the robot approaches you?



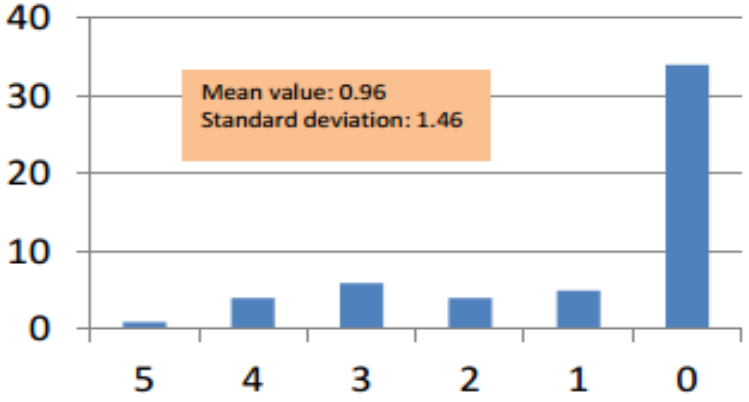
1.2
Does the robot invade your personal space?



1.3
Do you think robot movements are natural?

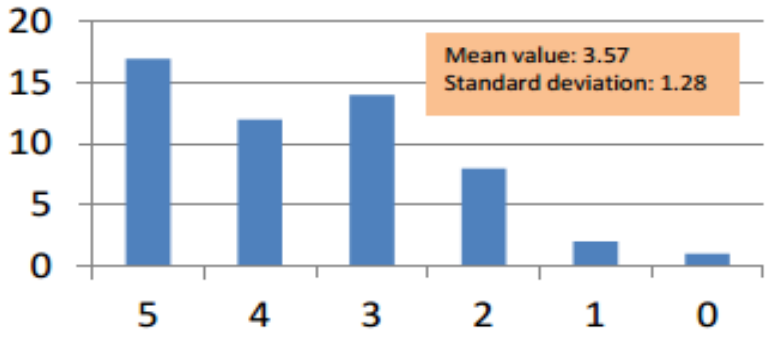


1.4
Have you stepped away from the robot, because you feared you could collide?

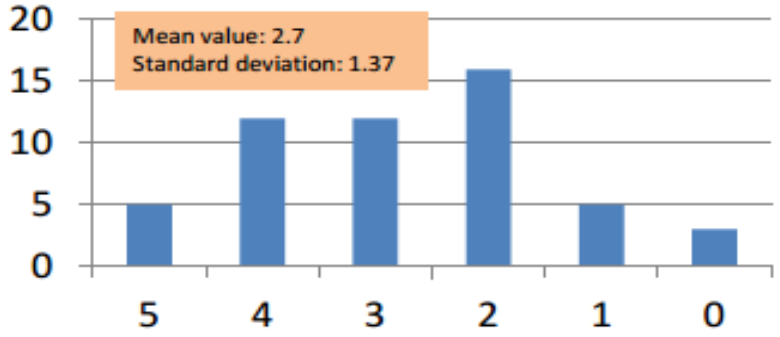


Final tests: Results

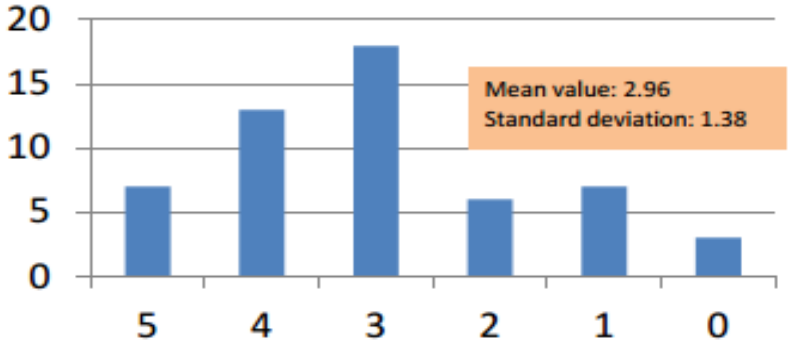
2.1
Have you understood what the robot told you?



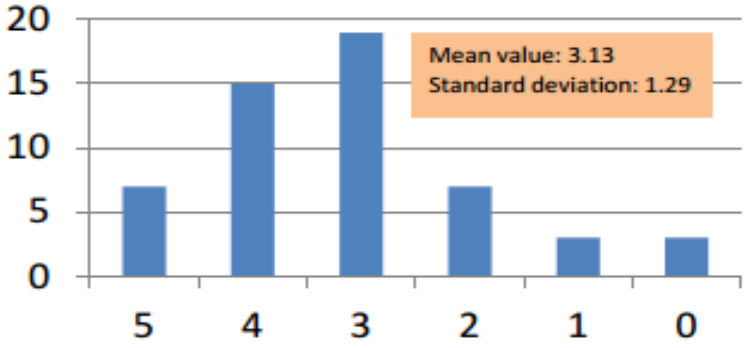
2.2
Do you think the robot understood you?



2.3
Could you maintain a coherent conversation?

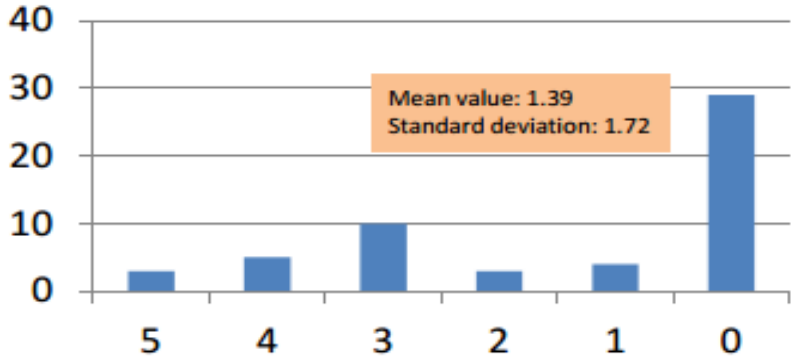


2.4
Do you think the robot has a pleasant voice?

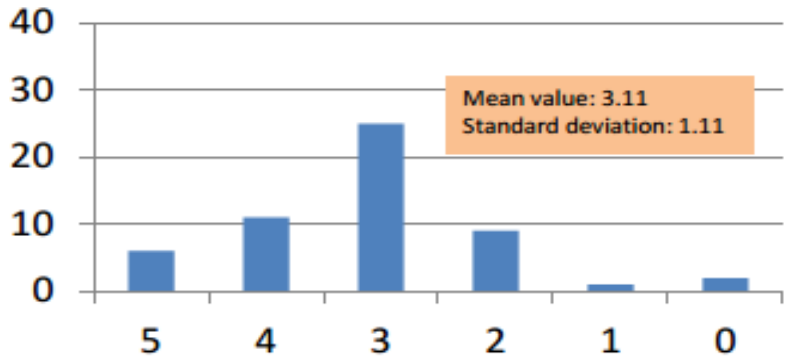


Final tests: Results

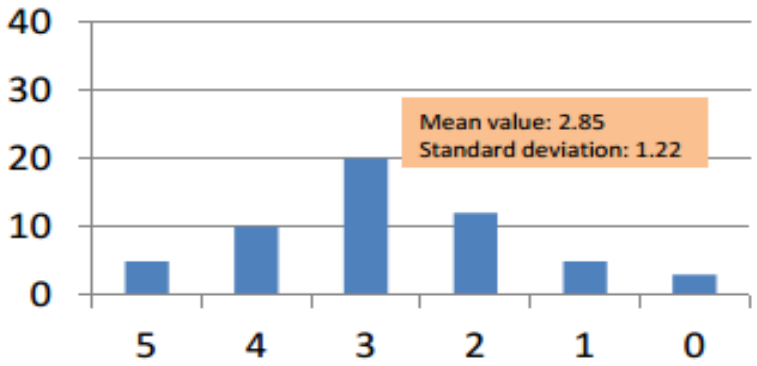
3.1
Did the robot get blocked during the interaction?



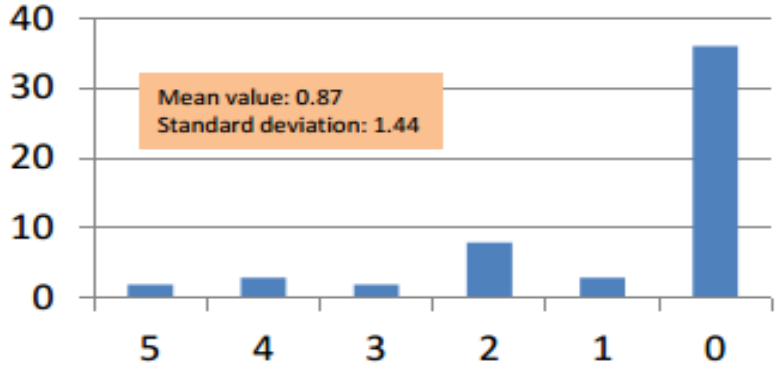
3.2
Do you think your interaction with the robot was natural?



3.3
Was the conversation fluent?

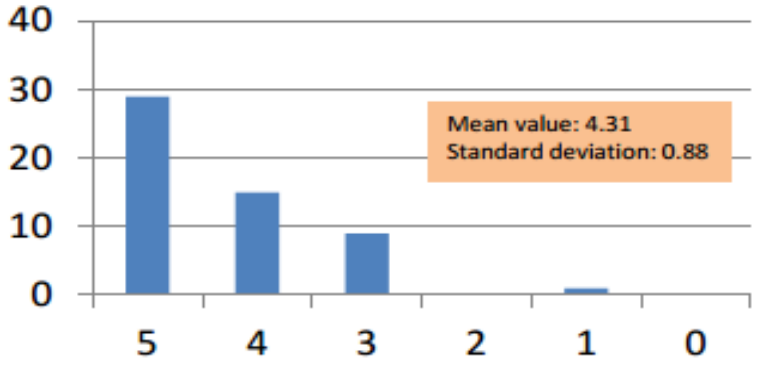


3.4
Did the robot seem to be controlled by a person?

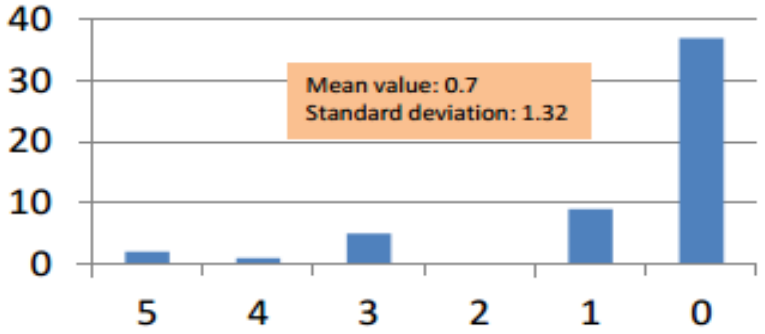


Final tests: Results

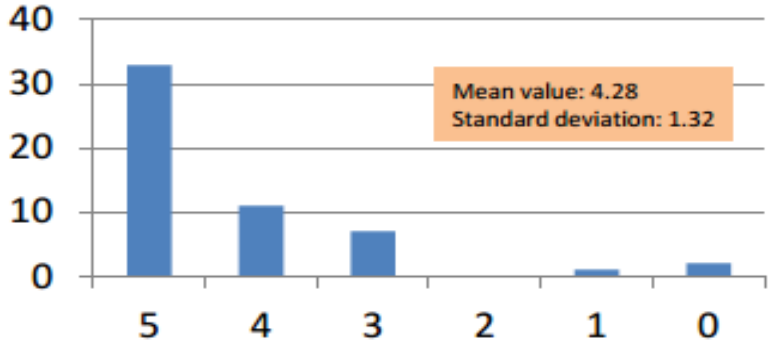
4.1
Did you enjoy the experiment?



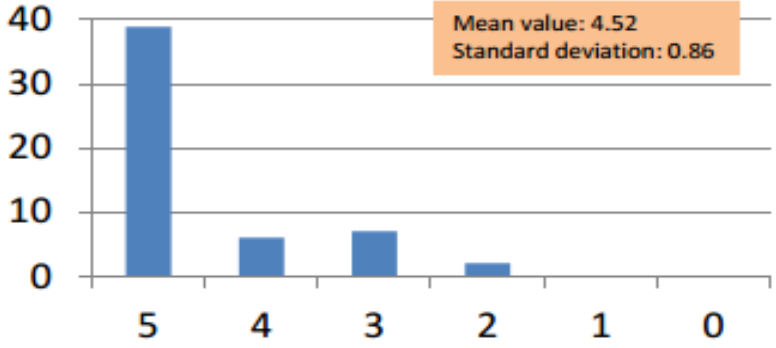
4.2
Do you think the experiment was not interesting?



4.3
Would you like to repeat the experience?



4.4
Would you recommend other people to interact with the robot?



Final tests: Results

Improved results after adding the touch panel

Question	$\bar{x}$	σ	$\bar{x}_{prev}$	σ_{prev}
2.1 Have you understood what the robot told you?	4.27	1.23	3.57	1.28
2.2 Do you think the robot understood you?	3.72	1.28	2.7	1.37
3.1 Did the robot get blocked?	1.42	1.71	1.39	1.72
3.2 Was the interaction natural?	3.06	1.22	3.1	1.11
3.3 Was the conversation fluent?	3.06	1.32	2.85	1.22
3.4 Did the robot seem to be tele-operated?	1.27	1.48	0.87	1.44
3.5 Was the touch screen useful for the interaction?	4	1.58	-	-
4.1 Did you enjoy the experiment?	4.63	0.54	4.31	0.88
4.3 Would you like to repeat?	4.51	0.75	4.28	1.32
4.4 Would you recommend it to other people?	4.69	0.58	4.52	0.86

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Conclusions

- CORTEX is able to work with different levels of abstraction in the same representation
- DSR appears as a powerful unified representation of the world
- Tested in real scenarios
- Future research:
  - Inject raw data in the representation (proxies)
  - Emulations

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TE Tecnología Electrónica Universidad de Málaga

Thank you very much!

Questions?

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