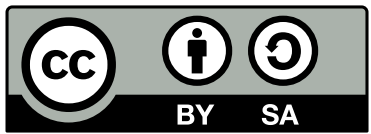

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You can download the sources of this presentation here:
github.com/severin-lemaignan/2023-understandability-dagstuhl

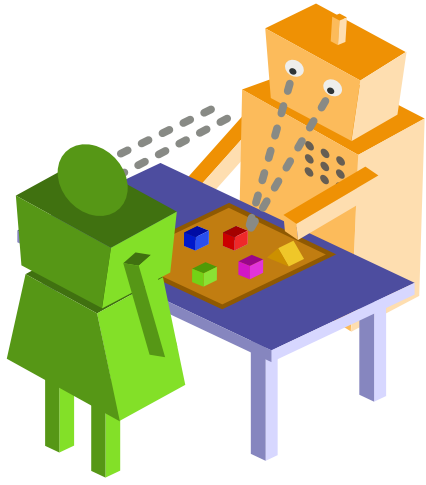
PAL ROBOTICS

ACCIÓ Generalitat de Catalunya

Understandability

Some food for thought in the context of HRI

Responsible Robotics | Dagstuhl Seminar, 11-15 Sep 2023



Séverin Lemaignan

PAL Robotics Head of Social Robotics, Senior Scientist AI & HRI

situation assessment

symbolic grounding

symbolic reasoning

responsible AI

SYMBOLIC SOCIAL COGNITION FOR ROBOTS

DATA-DRIVEN HRI

ontologies

perspective taking

cognitive architectures

persuasion

social situation assessment

joint action

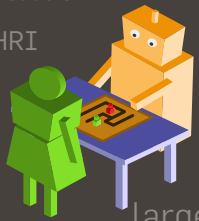
ROS4HRI

natural language processing

REAL-WORLD SOCIAL AUTONOMY

HUMAN FACTORS

human-in-the-loop ML



learning of social policies

theory of mind

group dynamics

large datasets

experimental robotics

CHILD-ROBOT INTERACTION

participatory design

robotics for learning

engagement

anthropomorphism

social robotics

PAL ROBOTICS

SOCIAL ROBOTICS

Major scientific challenges:

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- Close the interaction loop;
- Understand and sustain long-term autonomous social interactions;
- Real-world algorithmic robustness;
- Complex ethical landscape;
- $\Rightarrow$ cross-disciplinary & holistic approach required
- $\Rightarrow$ involve all the stakeholders; participatory approach

UNDERSTANDABILITY

…‘Understandability’?

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In EU’s Ethics Guidelines for Trustworthy AI, keywords like:

- transparency
- explainability (eg XAI)
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In other words, would eg explainability and tracability by themselves be sufficient to establish trust?

DO WE ACTUALLY REALLY WANT TO UNDERSTAND OUR ROBOTS?

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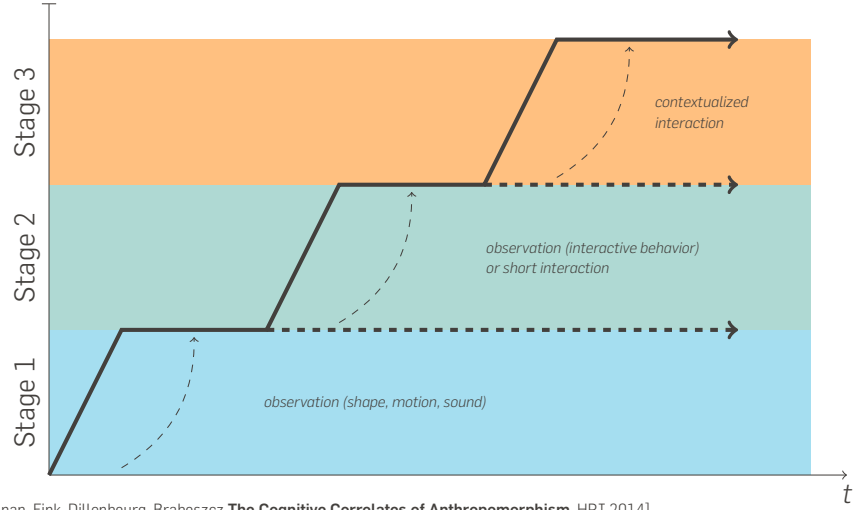
COGNITIVE INTERPRETATION?



adapted mental model
→ adapted interaction
(anthropomorphic or not)

projection of existing mental models
(familiarity)

pre-cognitive anthropomorphism

[Lemaignan, Fink, Dillenbourg, Braboszcz **The Cognitive Correlates of Anthropomorphism**, HRI 2014]

WHAT MEANS ‘RESPONSIBLE’ IN THAT CONTEXT?

If we adopt the cognitive perspective of *understanding* the robot as the **completion of a robust mental model** of the machine, where does that leave us wrt. *responsible* understandability?

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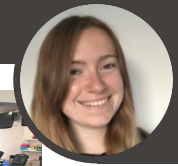
$\Rightarrow$ design robots’ behaviours to foster the creation of detailed and correct mental models

...or even let the end-users co-design the robot’s cognitive capabilities

End-to-end co-design: gym coach

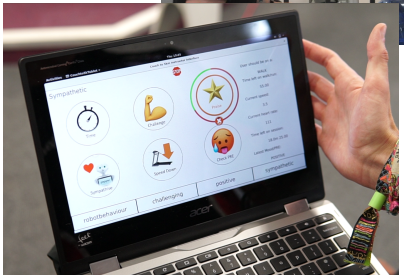
COUCH-TO-5K STUDY



- 9 participants
- 3 months; 27 one-hour sessions per participants
- $|state| = 20$; $|action\_space| = 11$
- Includes participants' personality (Big-5) as input feature

[Winkle et al. **In-Situ Learning from a Domain Expert for Real World Socially Assistive Robot Deployment** RSS 2020]

CO-DESIGN FOR REAL-WORLD + LONG-TERM



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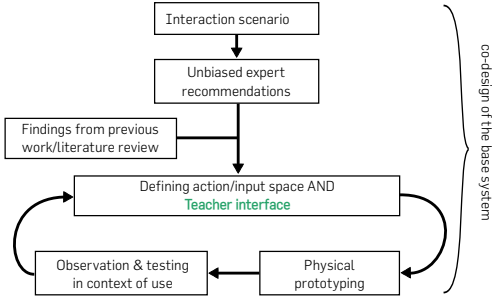
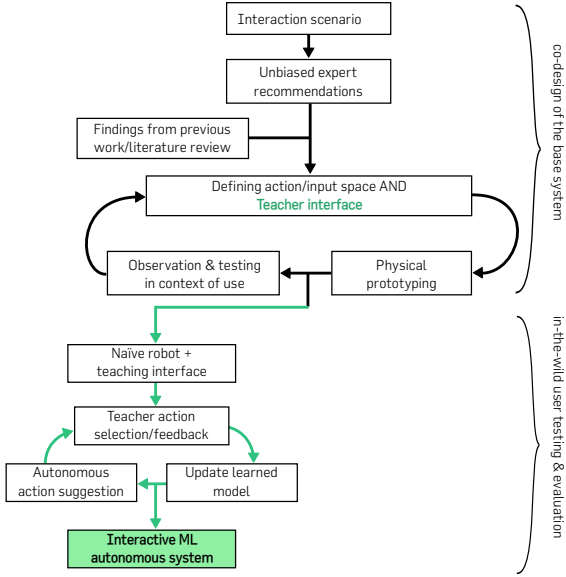
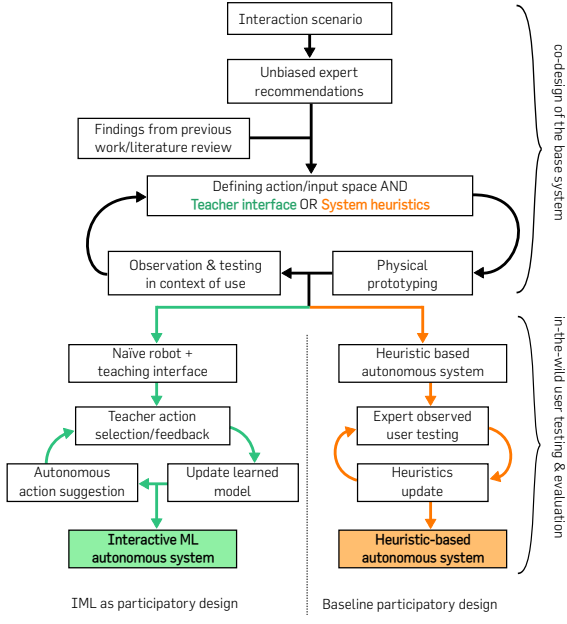

Interaction scenario
Unbiased expert recommendations
Findings from previous work/literature review
Defining action/input space AND
Teacher interface
Observation & testing in context of use
Physical prototyping
co-design of the base system



IML as participatory design


Interaction scenario
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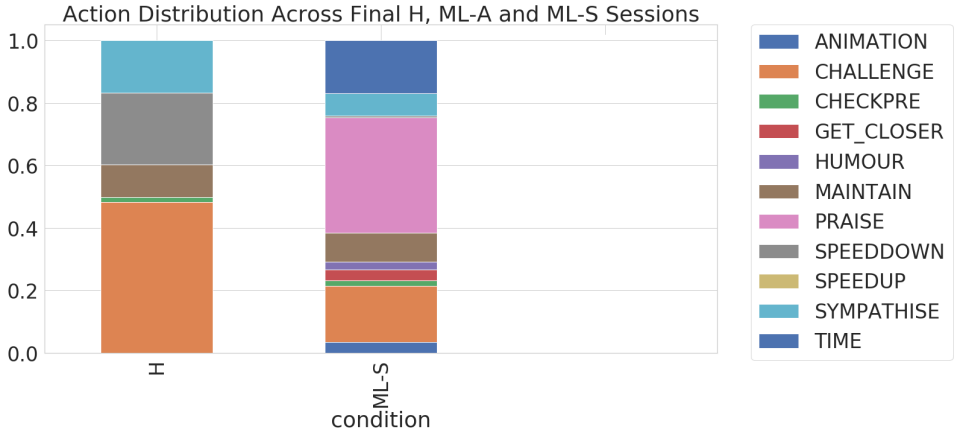
Physical prototyping
co-design of the base system
Naïve robot + teaching interface
Teacher action selection/feedback
Autonomous action suggestion
Update learned model
Interactive ML autonomous system
Heuristic based autonomous system
Expert observed user testing
Heuristics update
Heuristic-based autonomous system
in-the-wild user testing & evaluation
IML as participatory design
Baseline participatory design

LEARNT POLICIES



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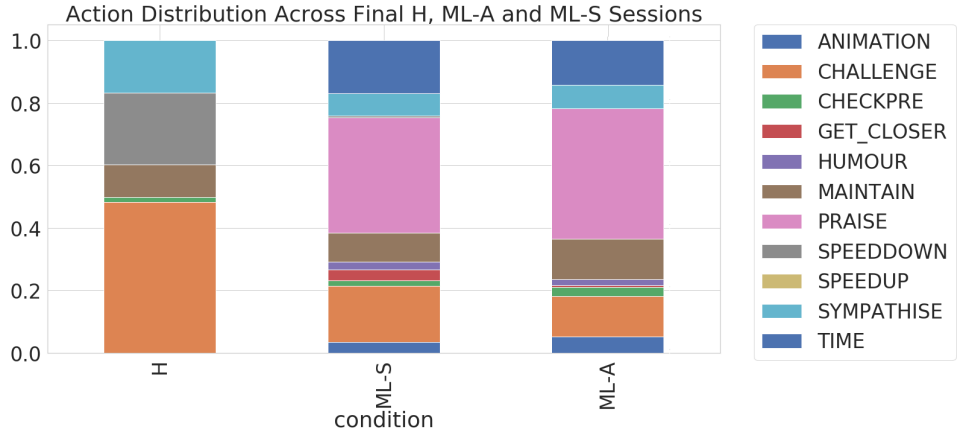

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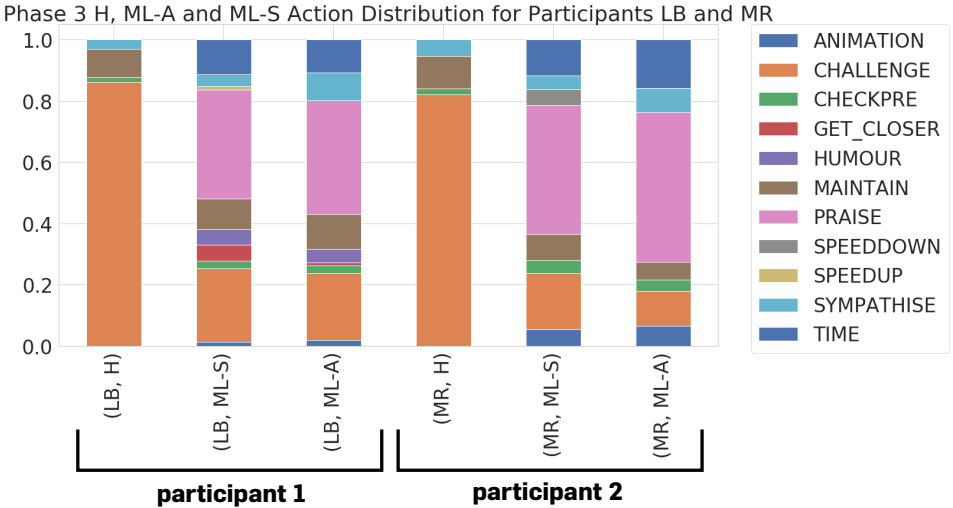

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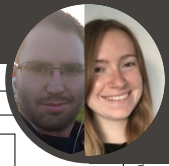
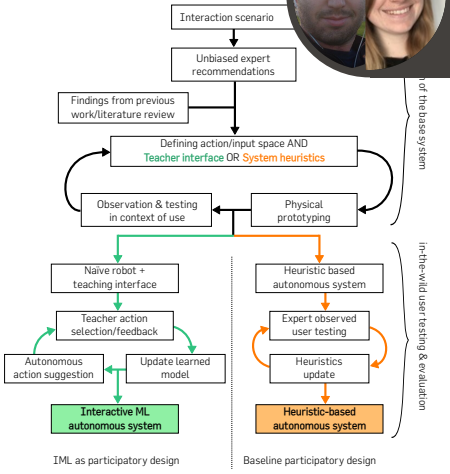
LEADOR: END-TO-END CO-DESIGN



- a successful technical solution to replace the wizard;
- but equally important, a **end-to-end** participatory design methodology (*LEADOR: Led-by-Experts Automation and Design Of Robots*)



[Senft et al. **SPARC: Supervised progressively autonomous robot competencies**, ICSR 2015;
Winkle et al. **LEADOR: End-to-End Participatory Design of Autonomous Social Robots** FrontiersIn AI & Robotics 2021]

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...is it *Responsible Robotics©*?

DOES IT TRANSLATE TO INDUSTRY?

Can we turn the LEADOR paradigm into a generic & robust enough technique for broad usage?

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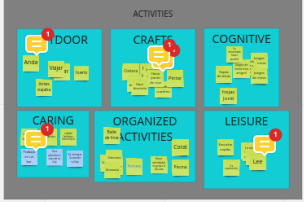
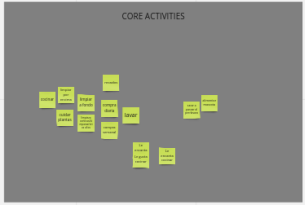
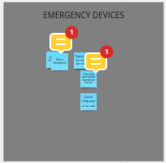
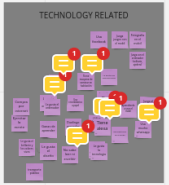
Two key use-cases for PAL Robotics:

- robots that know when to help in public administrations
- elderly care and isolation (but... **rHHI**: robot-supported Human-Human Interactions!)









NHoA: Never HOme Alone

Clínica Humana

Older person home (terrace)

Can Granada sheltered apartment

Older person home (reception)

AMIBA

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- robots do not live in isolation: think 'eco-systems' and embrace "mis-use"/mis-understanding of the robot
- from interaction to habits: (individualised) long-term *mutual shaping*
- importance of the regulatory framework (legal + ethical) to steer an otherwise 'engineering-focused' mindset

SOME FINAL REMARKS

Co-design requires bootstrapping: you need to understand at *some* level the physical (easy) and cognitive (much harder) capabilities of the robot to 'invent' its role

→ iterative process

→ slow process

(though more of a problem for traditional co-design than lifelong, end-to-end co-design)

SOME FINAL REMARKS

Sabanovic's *mutual shaping* is fundamental and not yet fully internalised by researchers/engineers

→ you (re)shape your relation to – and understanding of – the robot by using it

⇒ *Understanding* the robot likely means that the robot also has to understand you!

(here, the meaning of *understand* is left as an exercice to the reader)

SOME FINAL REMARKS

...as such:

can we really separate the human's understanding of the robot, from the robot's understanding of the human, of its environment, and... of itself? (introspection)

ANECDOTE: WHAT IF WE ASK THE SYSTEM TO EXPLAIN ITS BEHAVIOUR?

Sally (a girl) has 3 brothers. Each brother has 2 sisters. How many sisters does Sally have?

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PAL ROBOTICS

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GPT-4:

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`Sally (a girl) has 3 brothers. Each brother has 2 sisters. How many sisters does Sally have?` **`Let's think step by step.`**

GPT-4:

`Sally has 3 brothers. Each of these brothers has 2 sisters. This means that there are 2 girls in the family, including Sally. Therefore, Sally has 1 sister.`

(incidentally, GPT-4 is the only model out of 60 tested that get the correct answer)

Thank you!

We are always looking for great people to join us!

Drop me a line if you want to know more

PAL ROBOTICS