



Using developmental learning to improve human-robot interactions



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HoomanoTM
INTERACTIVE INTELLIGENCE FOR ROBOTS



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LIRIS and Hoomano: two complementary approaches

LIRIS: computer science Lab. SMA group: artificial intelligence and constructivist learning.

Hoomano: 3.5 years of experience in **developing** applications for social robots and **experimentations** with end-users.



What is Developmental Learning (DL)?

Bio-inspired

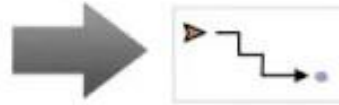
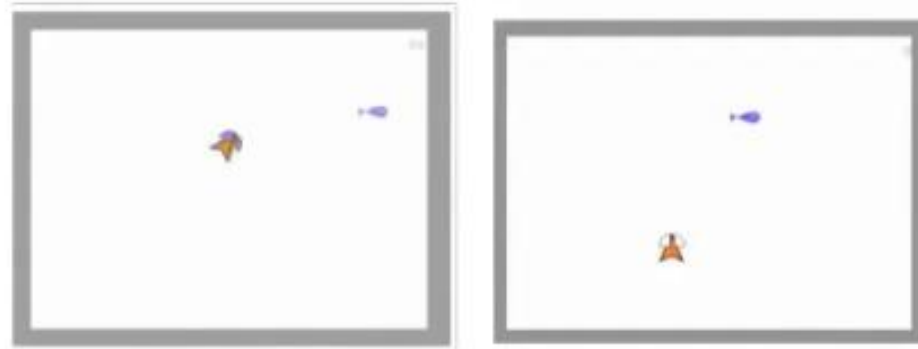
No prior **modelisation** of the environment

Learning **interaction regularities**

Intrinsic motivation, **curiosity**



Developmental learning as a clue to develop unique personalities for agents



oliviergeorgeon.com

11/8



Implementing rudimentary constructivist algorithms in Social Robots: the reality gap!

The first line represents the interactions the agent intended to enact (no background color means he just tries the experiment to see what happens)

What's in my mind?

Intentions:

- Interaction 1: [Icon]
- Interaction 2: [Icon]
- Interaction 3: [Icon]
- Interaction 4: [Icon]
- Interaction 5: [Icon]
- Interaction 6: [Icon]
- Interaction 7: [Icon]
- Interaction 8: [Icon]
- Interaction 9: [Icon]
- Interaction 10: [Icon]

Memory:

- Interaction 1: [Icon] 50
- Interaction 2: [Icon] 0
- Interaction 3: [Icon] 0
- Interaction 4: [Icon] 0
- Interaction 5: [Icon] 0
- Interaction 6: [Icon] 0
- Interaction 7: [Icon] 0
- Interaction 8: [Icon] 0
- Interaction 9: [Icon] 0
- Interaction 10: [Icon] 0

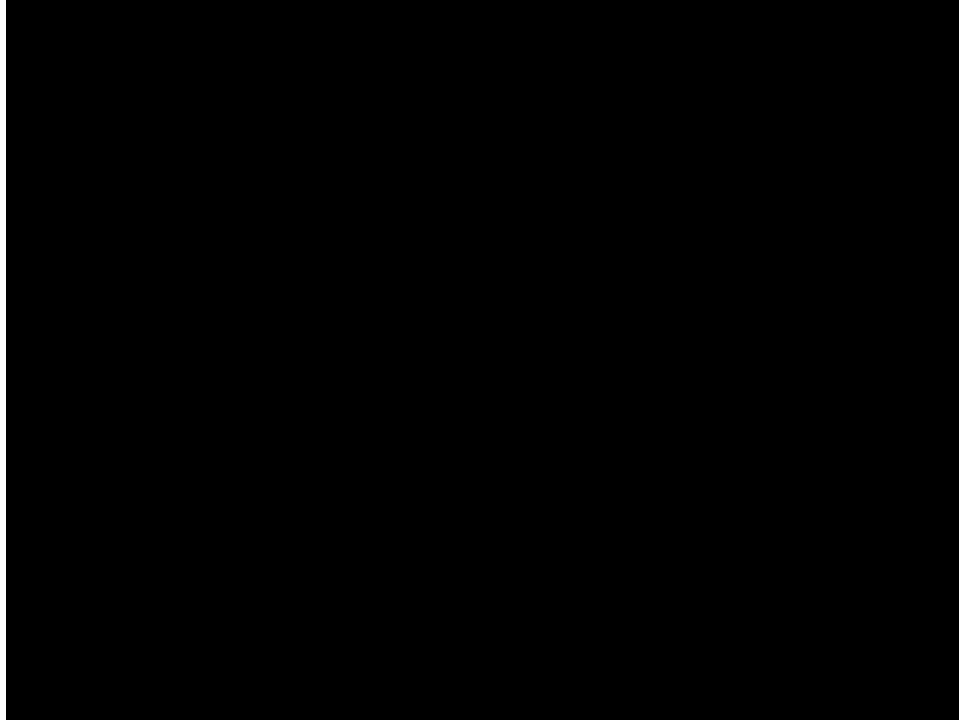
Logger:

```
Full log - Following memory instructions
Interaction 1
Requested action: interaction 1 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 2
Requested action: interaction 2 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 3
Requested action: interaction 3 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 4
Requested action: interaction 4 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 5
Requested action: interaction 5 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 6
Requested action: interaction 6 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 7
Requested action: interaction 7 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 8
Requested action: interaction 8 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 9
Requested action: interaction 9 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
Interaction 10
Requested action: interaction 10 - 0 - 0 - 0
Requested action: following memory instructions
Requested action: 0 - 0
```

Robot's Status:

0/100

Using DL to learn interaction preferences



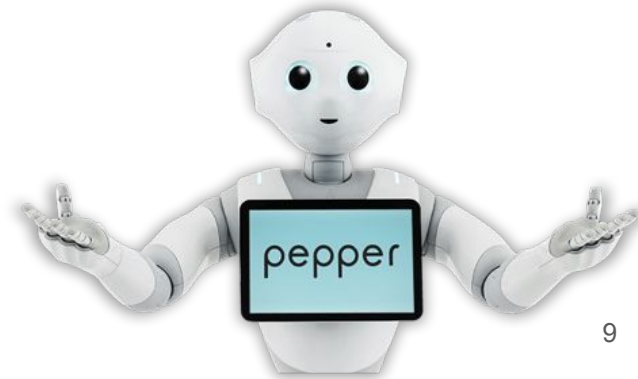
Ongoing work

DQN to adapt gestures to dialog content

Ongoing internship:

How to learn appropriate gestures (animations) as co-verbal information depending on a textual content?

- How to map “sentiment” and “gesture” without prior representation?
- How to gather feedback from users on the mapping quality?
- What are the other possible use-cases?



Multimodal learning with robotic data

Ongoing internship:

How to use multimodal learning with robotic data to improve awareness of robots?

- How to choose the data to combine?
- How to deal with poor quality of some data?
- What are the possible use-cases?
- What methodology to compare the architectures?



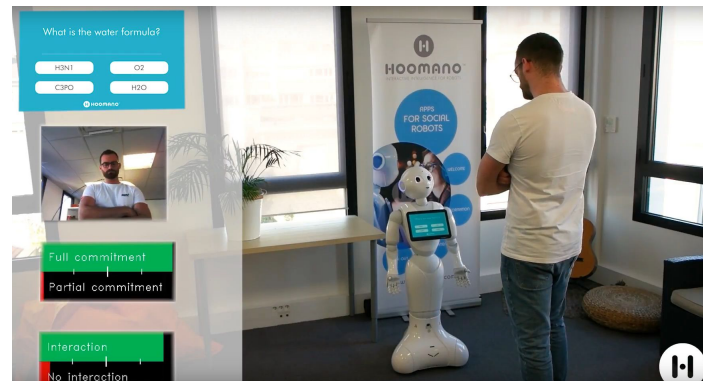
Modeling empathy with a focus on interaction

Ongoing PhD thesis:

Empathic Responses by Social-Robots in Human-Robot Interactions Using Developmental Learning

Experimentations in cognitive sciences:

How to measure the quality of an empathic response during a medium-term interaction - towards news tools inspired from psychology



What are we looking for?

Talents

The team is composed of interns, engineers, professors, PhD and post-docs... Join us!

Collaborations / partnerships

We are looking to extend our research and experiments fields...

And... any advice!

**We are
hiring!**

Publication

Developmental Learning for Social Robots in Real-World Interactions. Alexandre Galdeano, Alix Gonnot, Clément Cottet, Salima Hassas, Mathieu Lefort, Amélie Cordier. Human Robot Interactions (HRI). 2018.

Developmental Learning for Social Robots in Real-World Interactions

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BEHAVIORS.AI

- ▶ Joint lab between Hoomano and LIRIS.
- ▶ Founded by the French Research Agency (ANR).
- ▶ More info at <http://behaviors.ai>

Research objective

- ▶ **Make HRI more natural, more intuitive using developmental learning.**
- ▶ **High adaptation to dynamic environments that include humans.**

Problem statement

- ▶ Scripted behaviors.
- ▶ Lack of social intelligence.
- ▶ Not suited to the dynamic context of HRI.

Methodology: developmental learning

- ▶ An approach inspired by theories on the cognitive development of human being.
- ▶ An online, unsupervised learning algorithm based on few or no prior knowledge on the environment.
- ▶ The agent interacts with its environment to build its own representation of the world.

Implementation

- ▶ Construction of sequences of interactions represented as a 2-tuples (experiment, result).
- ▶ Robot implementation of a previous algorithm performing well in simulation.
- ▶ The algorithm enables NAO to learn sequences of two interactions according to the user's preferences.
- ▶ Two major obstacles encountered: speed and reliability.



Interface

- ▶ Visualizing the algorithm's execution trace and modifying it on the fly.
- ▶ Setting up some of the algorithm's parameters.
- ▶ Controlling the algorithm's execution.
- ▶ Enabling to produce configurations ready to be tested in real-world experiments.



Perspectives

- ▶ Improving the algorithm to get more complex behaviors.
- ▶ Using high level actions and perceptions for scalability.
- ▶ Evaluating the impact on the user's experience.

Thank you!

