

# Dr. Séverin Lemaignan

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Socially-driven autonomous robots  
for real-world Human-Robot Interactions

## SHORT BIO

- **2008–2012** Joint French (LAAS-CNRS) German (TU Munich) PhD  
AI & Cognitive Robotics  
Prix GdR Meilleure thèse
- **2013–2015** Post-doc at EPFL  
Creation of the HRI team  
Two main projects: *CoWriter* & *Cellulo*
- **2015–2018** Post-doc at Plymouth University, UK  
EU Marie Curie fellowship  
Social Cognition in Robotics
- **2018–** Associate Prof. at Bristol Robotics Lab



situation assessment

symbolic grounding

symbolic reasoning

## SYMBOLIC SOCIAL COGNITION FOR ROBOTS

ontologies

perspective taking

cognitive architectures

social situation assessment

joint action

ROS4HRI

natural language processing

## REAL-WORLD SOCIAL AUTONOMY

learning of social policies

## DATA-DRIVEN HRI

theory of mind

large datasets

human-in-the-loop ML

group dynamics

responsible AI

social robotics

experimental robotics

child-robot interaction

## HUMAN FACTORS

robotics for learning

persuasion

engagement

anthropomorphism

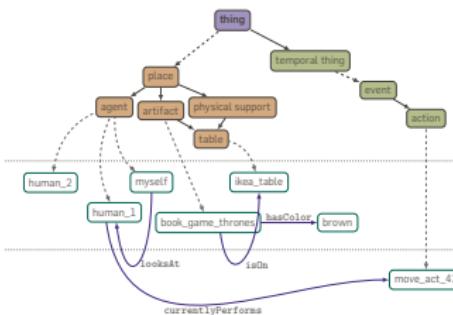
participatory design



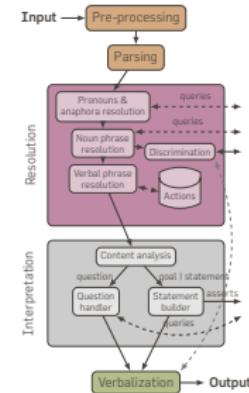
# SYMBOLIC SOCIAL COGNITION FOR ROBOTS



- real-time situation assessment
- geometric reasoning
- perspective-taking



- ontologies
- real-time symbolic reasoning
- theory of mind



- symbolic grounding
- natural language processing
- interactive disambiguation and concept learning

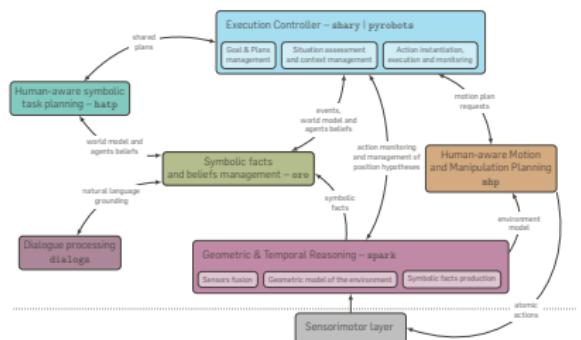
## SYMBOLIC SOCIAL COGNITION – main contributions

1. **ontologies** to model the robot knowledge
2. **situation assessment** using real-time 3D models of the environment to generate symbolic facts
3. **perspective taking** and **theory of mind**: generate and maintain symbolic knowledge models for all the agents
4. Application: **perspective-aware situated dialogue** with real-time **symbolic grounding**

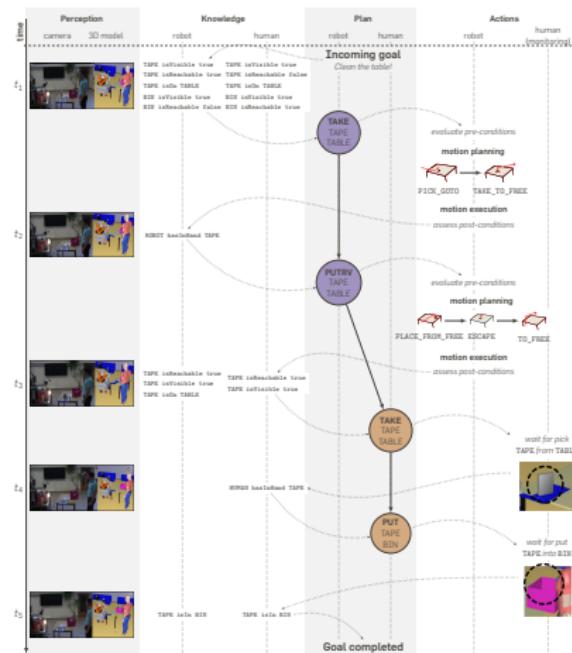
Impact:

- Prix GdR Meilleure thèse
- 10+ publications, incl. *Intl. Journal of Social Robotics*; *IROSx2*; *HRI*; *RoMANx2*; 500+ citations

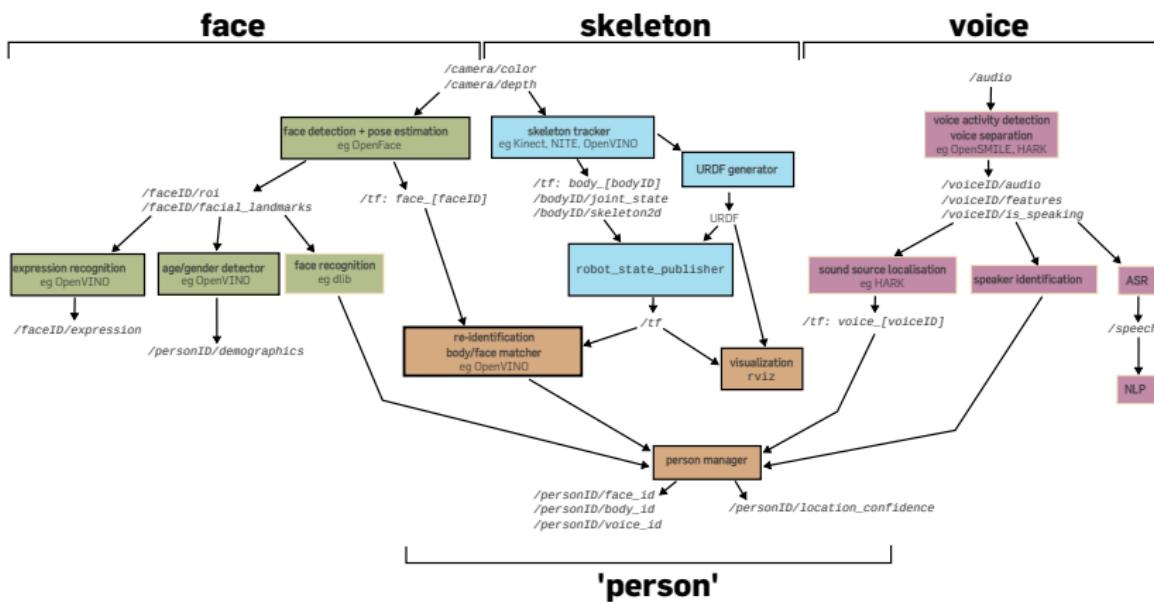
# REAL-WORLD SOCIAL AUTONOMY – cognitive architectures



- full socio-cognitive architecture for robot autonomy
- semantic-driven via semantic blackboard
- full interaction loop: NLP, joint goals, joint actions, real-time monitoring



# REAL-WORLD SOCIAL AUTONOMY – social signal processing



ROS4HRI: first integrated, multi-modal, ROS-based pipeline for social signal processing in robotics

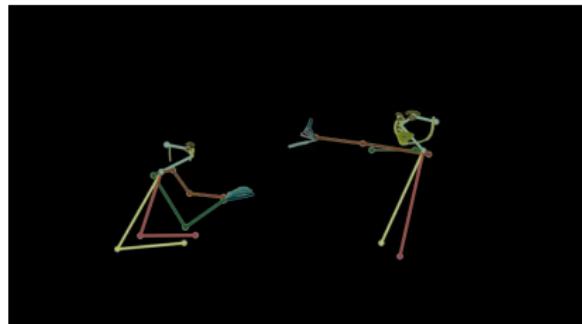
# REAL-WORLD SOCIAL AUTONOMY – main contributions

1. state-of-art **cognitive architecture for social interaction**
2. framing **semantic-aware robotic architectures**
3. large-scale, multi-modal, standard-compliant **social signal processing** for robots

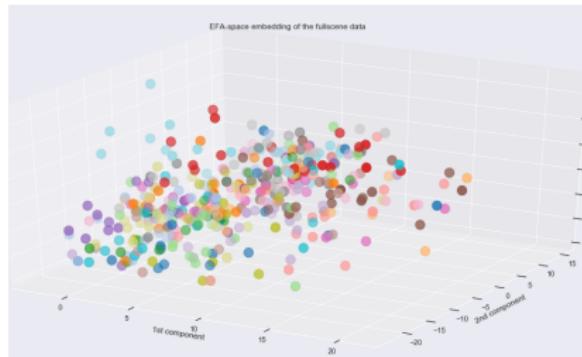
Impact:

- o major publications, incl. *Artificial Intelligence*, *HRI*, *IROS*; 800+ citations
- o 2nd most cited paper ever from *Artificial Intelligence*
- o major contribution to open-source robotics; 150+ GitHub repos

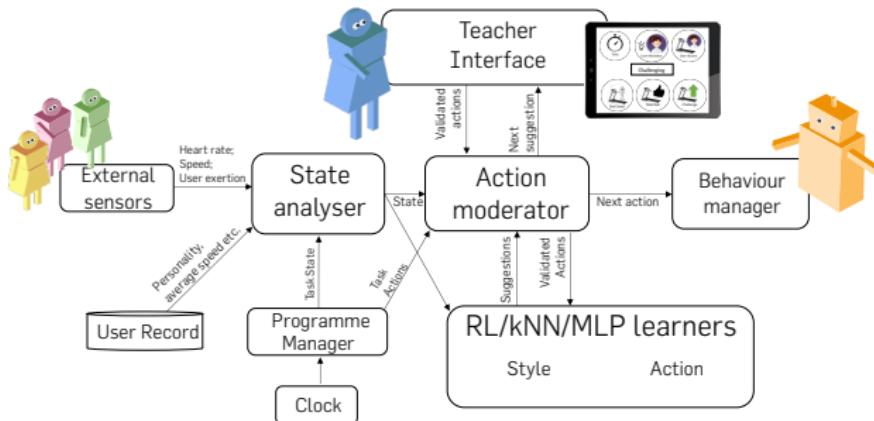
# DATA-DRIVEN HRI – dataset of natural interactions



- PInSoRo dataset: 45h+ and 2M frames of annotated natural interactions
- new data analysis techniques to estimate internal state from body language
- first-in-kind dataset for data-driven study of social interactions in robotics



# DATA-DRIVEN HRI – expert-in-the-loop machine learning



[Senft et al. Teaching robots social autonomy from in situ human guidance Science Robotics 2019]

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

## DATA-DRIVEN HRI – summary of contributions

1. leading role in **shaping the emergent field of data-driven HRI**
2. pioneering work on methodology: **large datasets** and **data-driven behaviour analysis** for social robotics, drawing from both psychology and AI.
3. major advances towards **learning autonomous social policies** for service robots with **real-world robot deployments**

Impact:

- o top publications incl. *Science Robotics*, *FrontiersIn Robotics and AI*, *PLOS One*, *RSS*, 300+ citations
- o first large-scale and open dataset of natural social interactions

# HUMAN FACTORS – experimental work

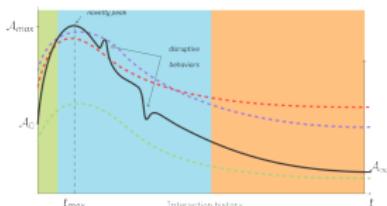
Extensive experimental work:

- over 25 field experiments over the past 10 years
- focus on real-world experiments (eg schools, gyms)
- child-robot interaction expertise: worked with 200+ children

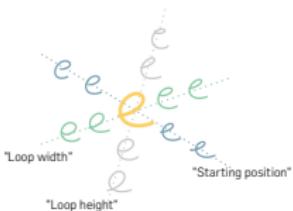


# HUMAN FACTORS – expertise

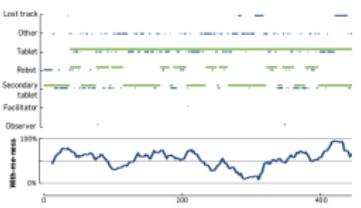
## Understanding interaction



## Robots for Learning



## Methodology



## HUMAN FACTORS – summary of contributions

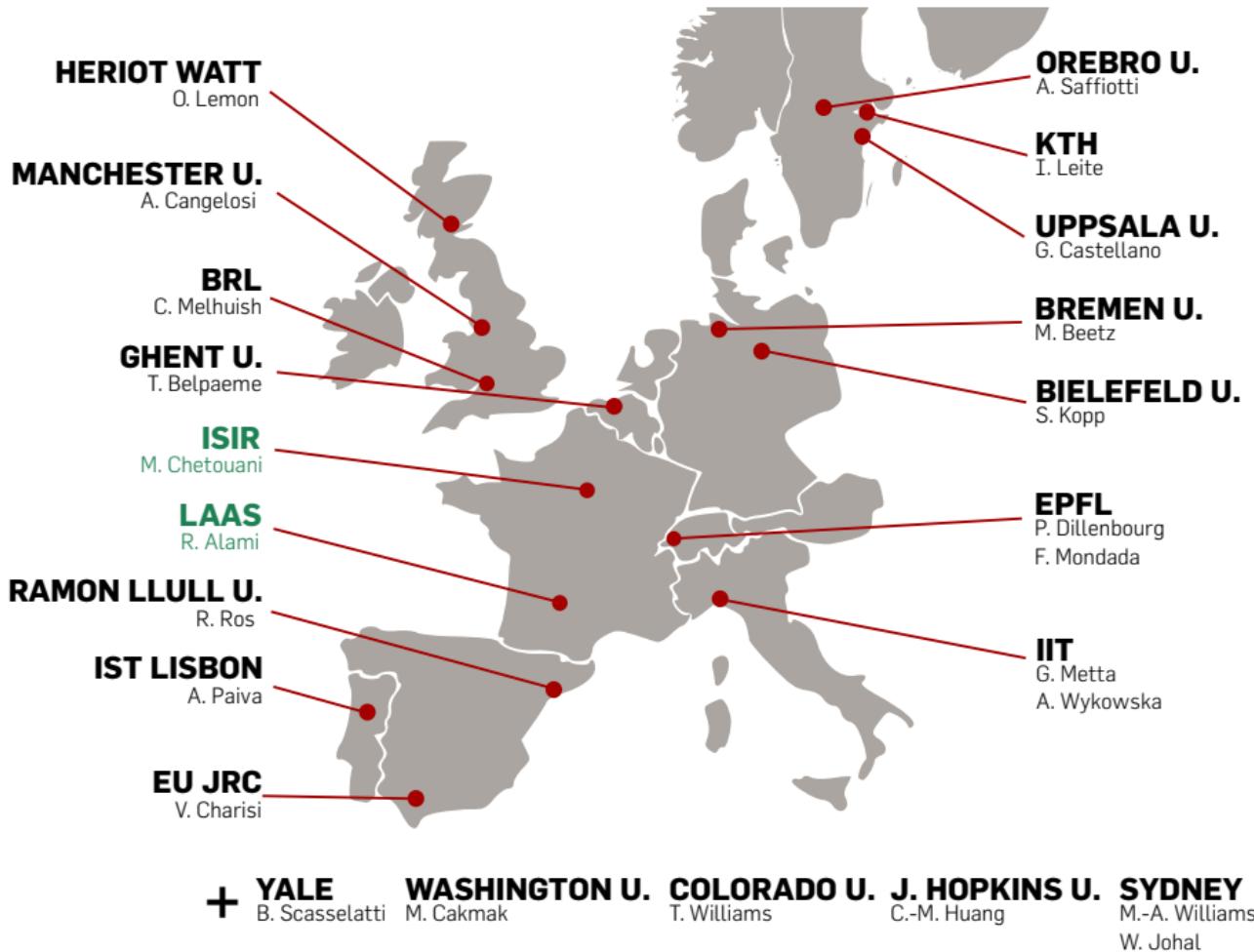
1. transdisciplinary expertise: key role in **bridging research in cognitive psychology with robotics**
2. number of **cross-disciplinary experimental work** and literature surveys
3. major contribution to **child-robot interaction**, in particular the **importance of social engagement** between children and robots

Impact:

- o 20+ publications on human factors and experimental robotics, 1000+ citations
- o EU H2020 Marie-Curie fellowship on Theory of Mind
- o invited expert to EU & UNICEF on the Ethics of child-robot interactions

# ASSOCIATE PROF IN SOCIAL ROBOTICS AND AI

- **Supervising 2 groups** at BRL (embodied cognition and autonomous vehicles), **≈15 researchers**, **>€1M funding**
- Supervised or co-supervised **9 PhDs** to date
- **75+ publications** (incl. eg *Science Robotics*, *PLOS One*, *Artificial Intelligence*), mostly in HRI (2800+ citations, i-index=25 on Google Scholar)
- **Programme committee/editorial board** of *FrontiersIn Robotics and AI*; *HRI*; *RSS*; *IROS*; *IJCAI*
- First **ERC Consolidator submission** in 2019
- Significant **technical contributions** (ROS, large datasets, 150+ repos on Github)
- **Policy making**, eg expert on ethics of child-robot interaction to EU and UNICEF



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# RESEARCH PROJECT

# SOCIAL ROBOTICS

Creating interactive robots that are **embedded and understand their (human) social context; generate and adopt appropriate social behaviours; have a positive impact on human society.**

⇒ designing and implementing the **assistant and companion robots** for tomorrow.

⇒ direct impact on ageing society, education, customer service; **major societal challenge & European priority.**



# SOCIAL ROBOTICS

## Major scientific challenges:

- Understand and sustain long-term autonomous social interactions;
- Real-world algorithmic robustness;
- Complex ethical landscape;
- ⇒ cross-disciplinary & holistic approach required



# SOCIAL ROBOTICS

## Major scientific challenges:

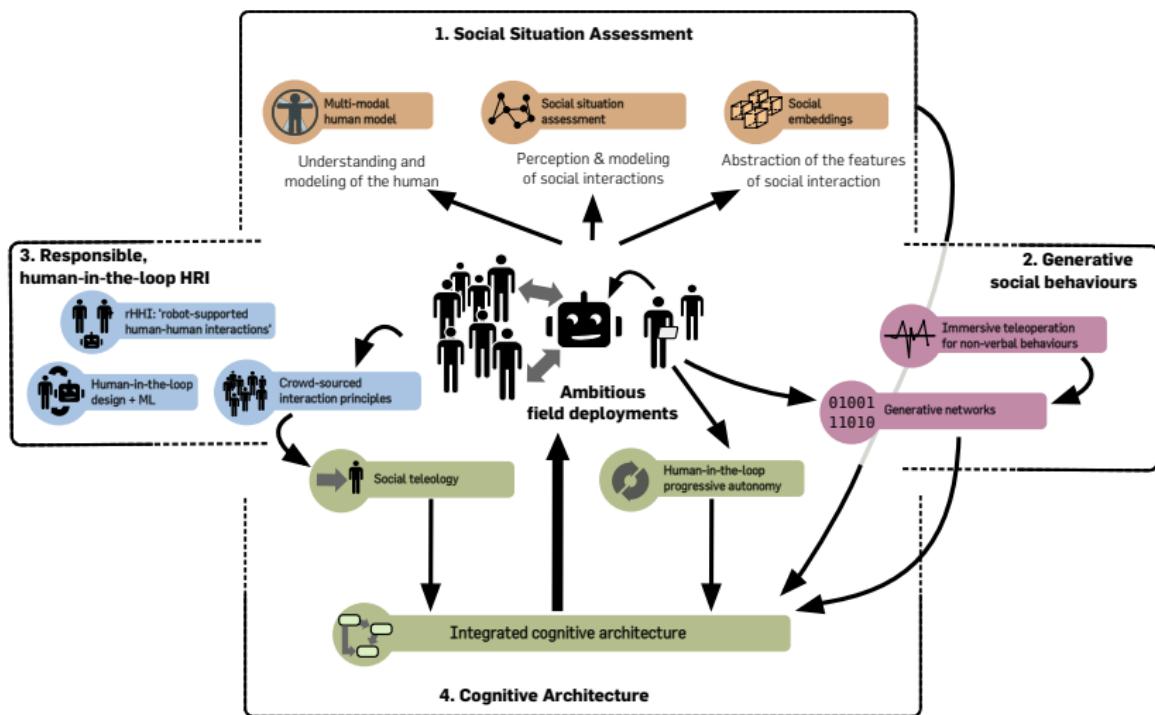
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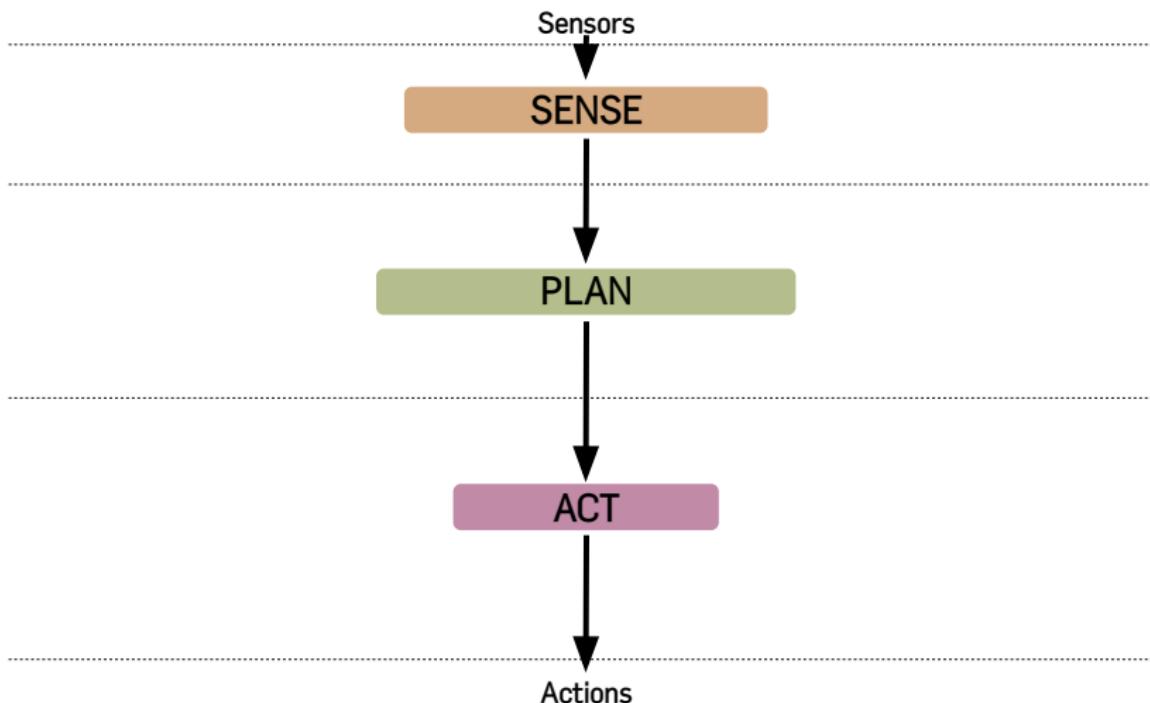
## My research proposal:

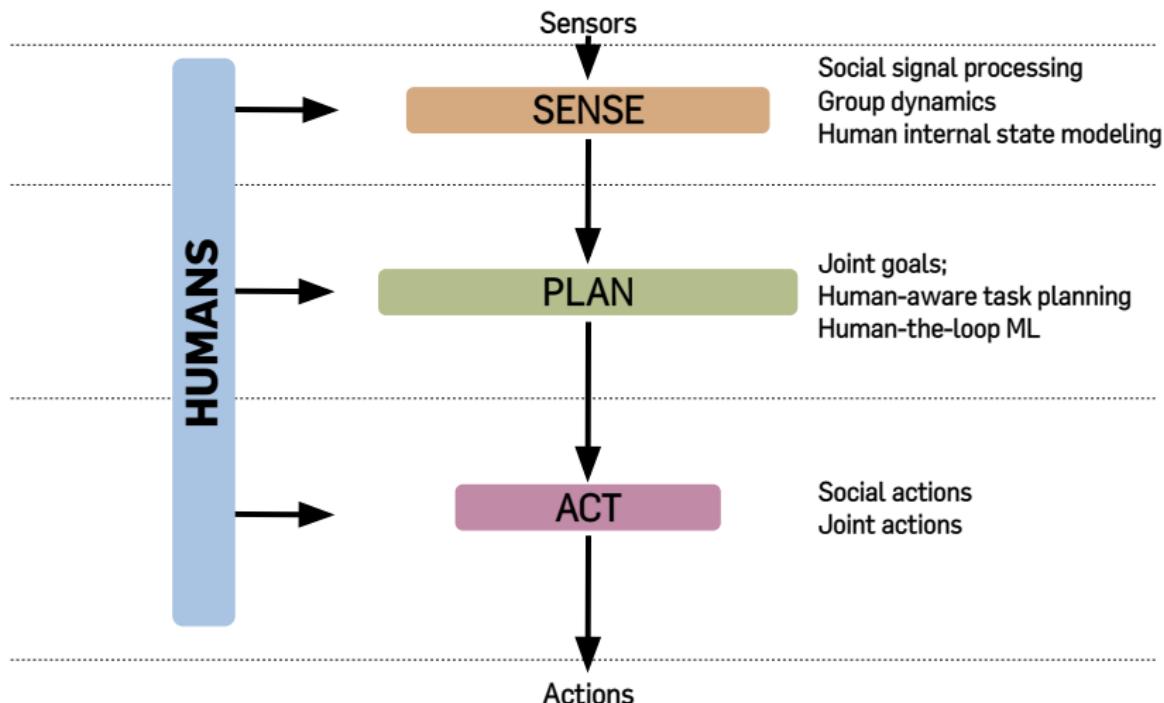
**Socially-Driven Autonomous Robots  
for  
Real-world Human-Robot Interactions**

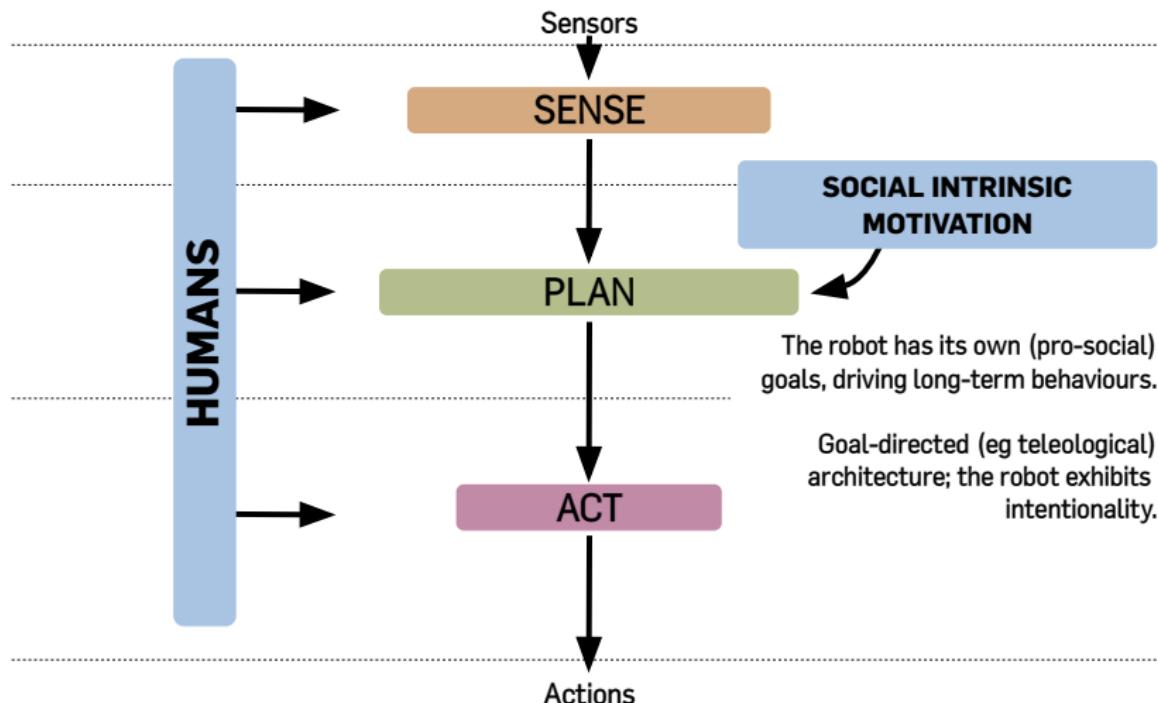


# A HOLISTIC APPROACH

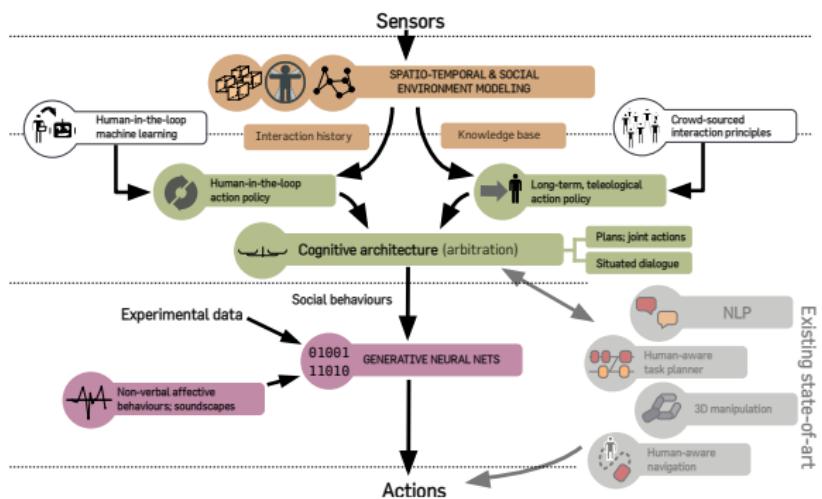








# KEY SCIENTIFIC AIMS



1. beyond state-of-art **robust real-world social modelling; social embeddings**
2. **public-in-the-loop** approach to design of **intrinsic social motivation**
3. **generative social behaviours** for robots
4. **cognitive architecture** for long-term interaction

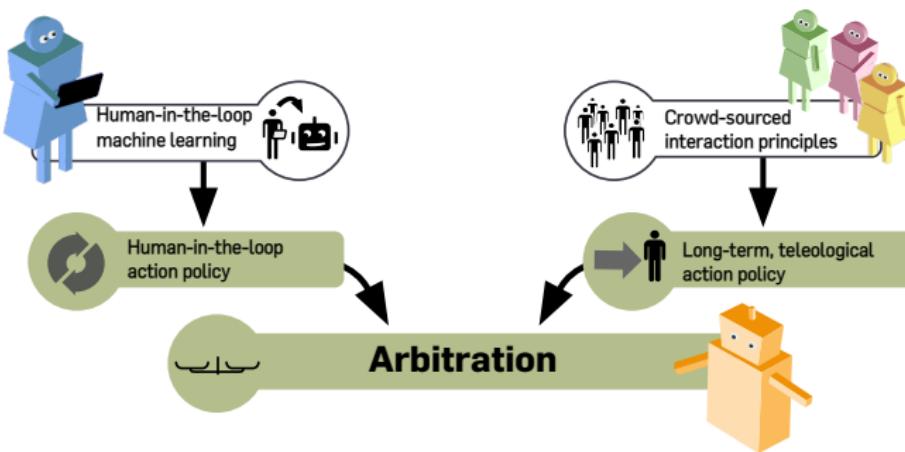
# FOCUS: SOCIAL EMBEDDINGS



**social embeddings:** learning a compact, sub-symbolic representation of social interactions

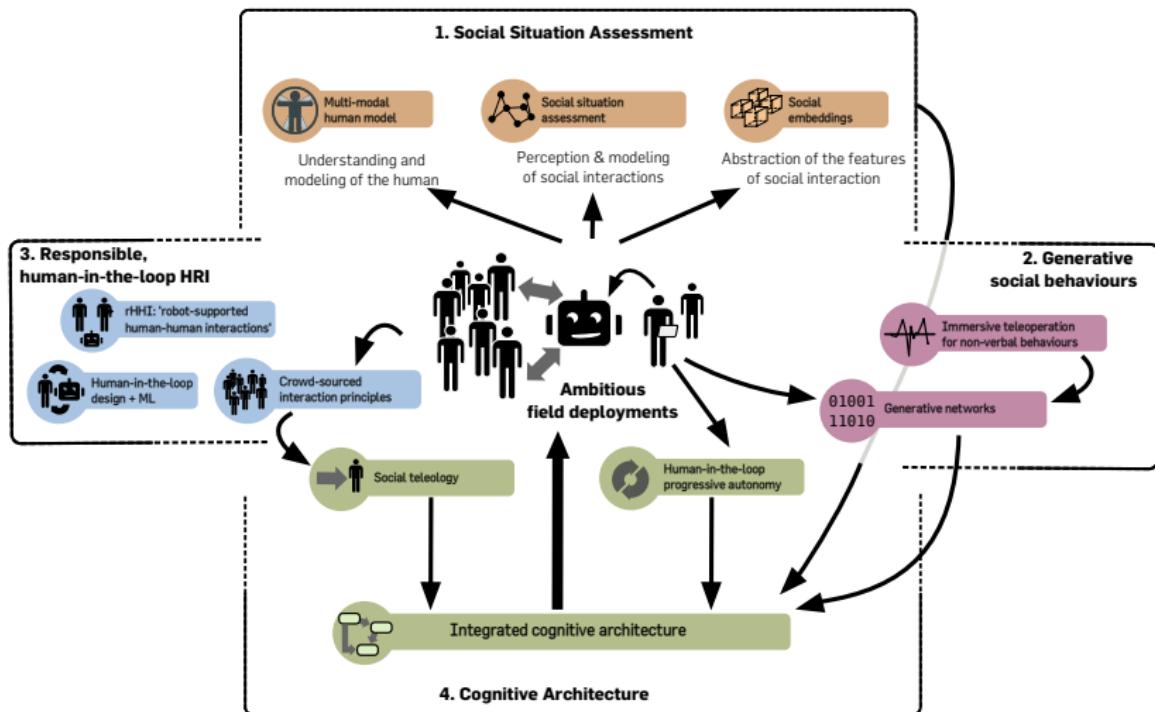
- real-world social interactions are highly dynamic, noisy, multi-modal
- hard for the robot to model and reason about
- → **learn an embedding:** Attention nets, Deep graph nets
- can be used by the robot to **recognise social situation** and **generate congruent social behaviours**

# FOCUS: HUMAN-IN-THE-LOOP ACTION POLICIES



- **end-users and public to play a key role:**
- **crowd-sourced pro-social goals** (eg 'show attention', 'appear alive') drives long-term behaviours
- **short-term/domain-specific policies learned** via interactive reinforcement learning (IRL)
- **cognitive arbitration** between the two, based on **experience transfer**

# A HOLISTIC APPROACH TO SOCIAL ROBOTICS



## INTEGRATION LAAS



- Long-standing expertise in autonomous social robots (R. Alami) → natural integration to RIS team
- Excellent infrastructure & access to robots
- Software engineering expertise almost unique in academia
- ANITI: Excellent academic environment & collaboration opportunities

# INTEGRATION LAAS

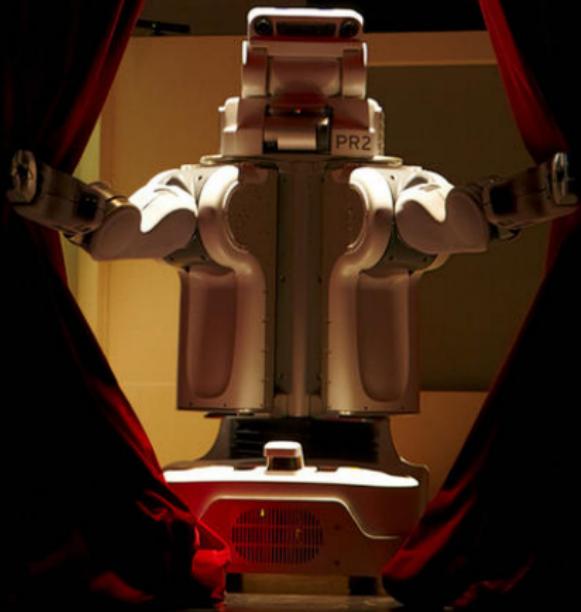


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## **What I would bring:**

- Experimental know-how with extensive expertise in real-world deployments
- Emerging theme: Data-driven HRI
- ANITI: transverse applications for AI and robotics

Thank you!



*(photo of roboscopie, a theatre play I  
created with director Nicolas Darrot  
in 2012)*