

Dr. Séverin Lemaignan

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



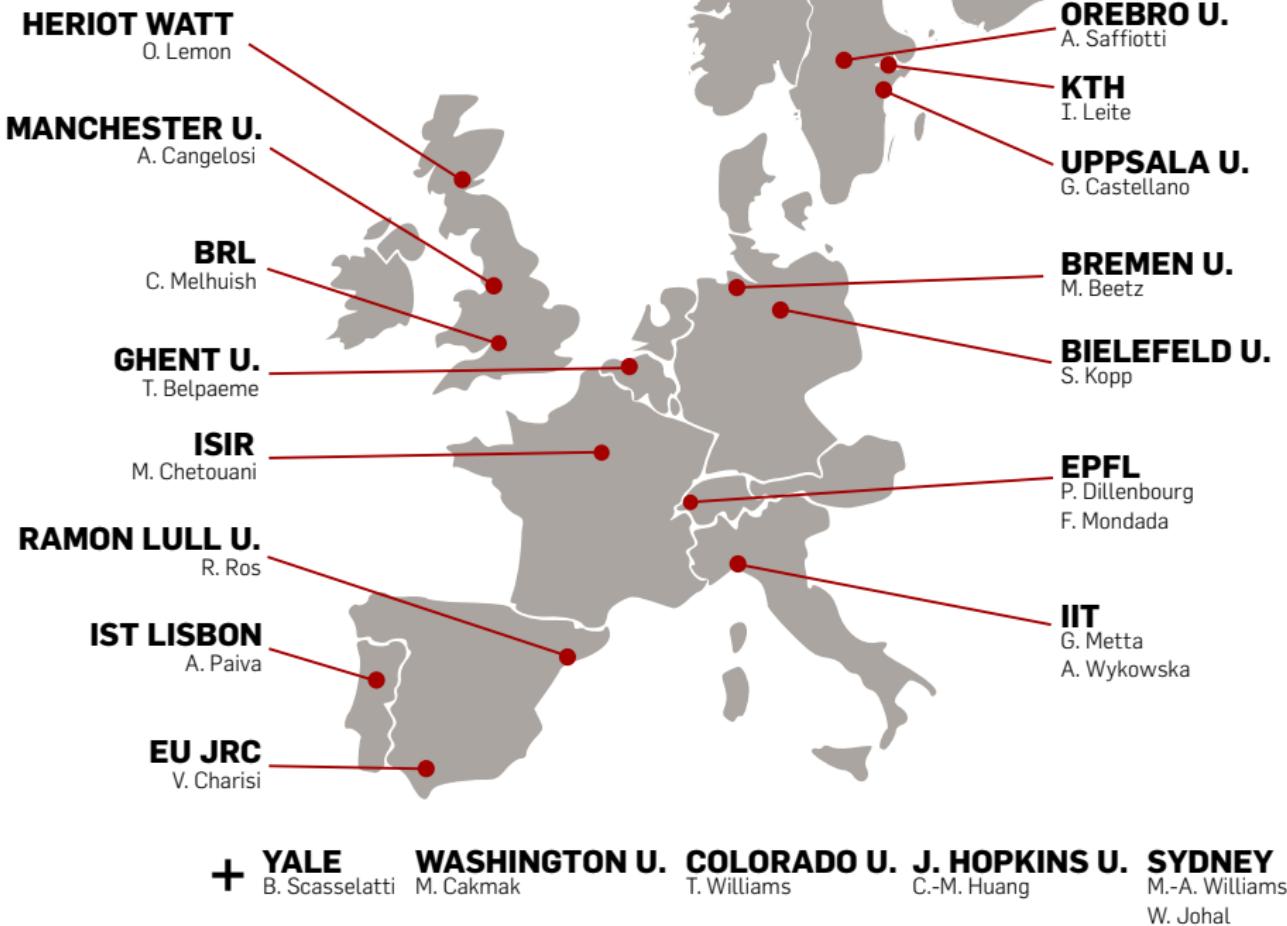
SHORT BIO

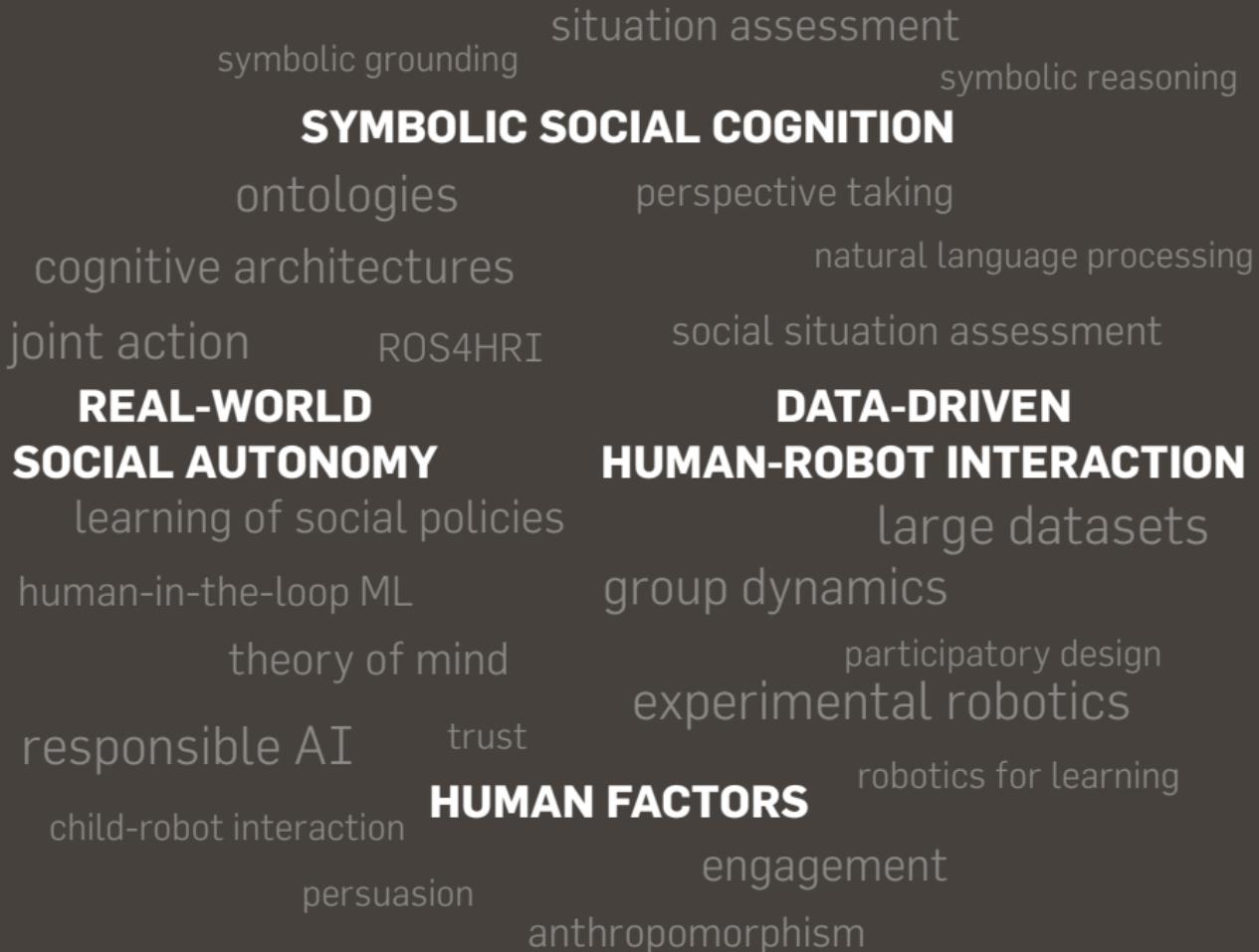
- **2008–2012** Joint French (LAAS-CNRS) German (TU Munich) PhD
AI & Cognitive Robotics
Prix GdR Meilleure thèse
- **2013–2015** Post-doc at EPFL
Creation of the HRI team
Two main projects: *CoWriter* & *Cellulo*
- **2015–2018** Post-doc at Plymouth University, UK
EU Marie Curie fellowship
Social Cognition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



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
- Programme committee/editorial board of FrontiersIn Robotics and AI; HRI; RSS; IROS; IJCAI
- 75+ publications (incl. eg *Science Robotics*, *PLOS One*, *Artificial Intelligence*), mostly in HRI (2800+ citations, i-index=25 on Google Scholar)
- Significant technical contributions (ROS, large datasets, 150+ repos on Github)
- Policy making, eg expert on ethics of child-robot interaction to EU and UNICEF



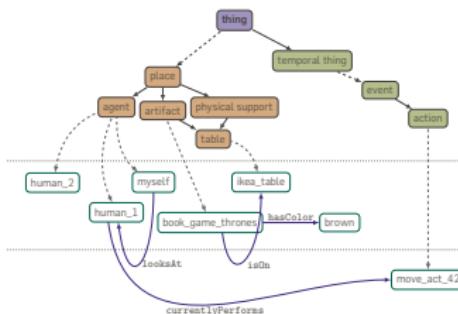


1. SYMBOLIC SOCIAL COGNITION

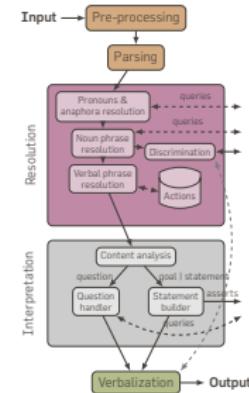
FULLY SOLVING “CAN YOU GIVE ME THAT BOOK?”



- 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:

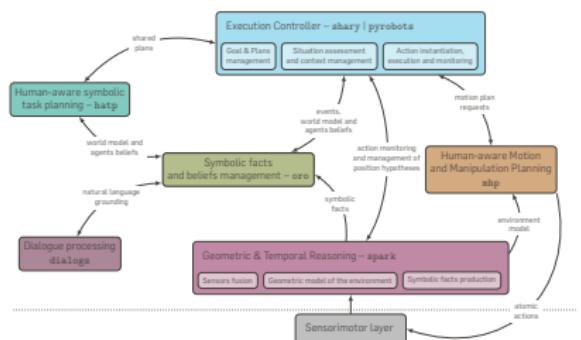
1. **ontologies** to model the robot knowledge
2. **situation assessment** using real-time 3D models of the environment to generate symbolic facts
3. **perspective taking** and **theory of mind**: generate and maintain symbolic knowledge models for all the agents
4. Application: **perspective-aware situated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

Impact:

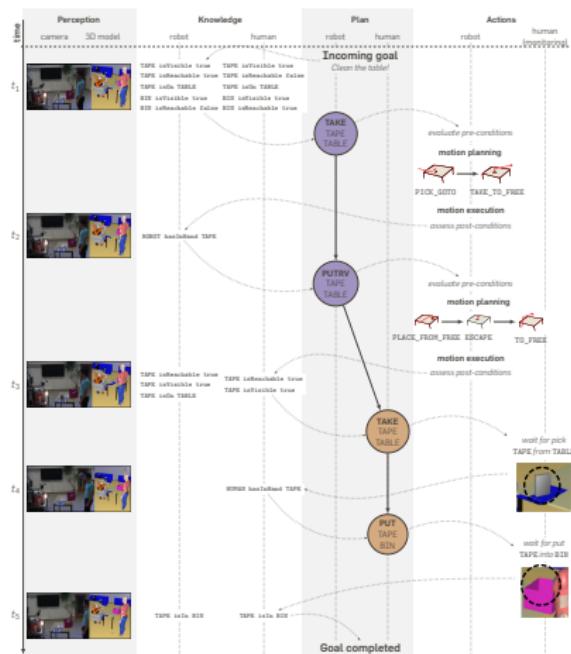
- Prix GdR Meilleure thèse
- 10+ publications, incl. *Intl. Journal of Social Robotics; IROSx2; HRI; RoMANx2*; 500+ citations

2. REAL-WORLD SOCIAL AUTONOMY

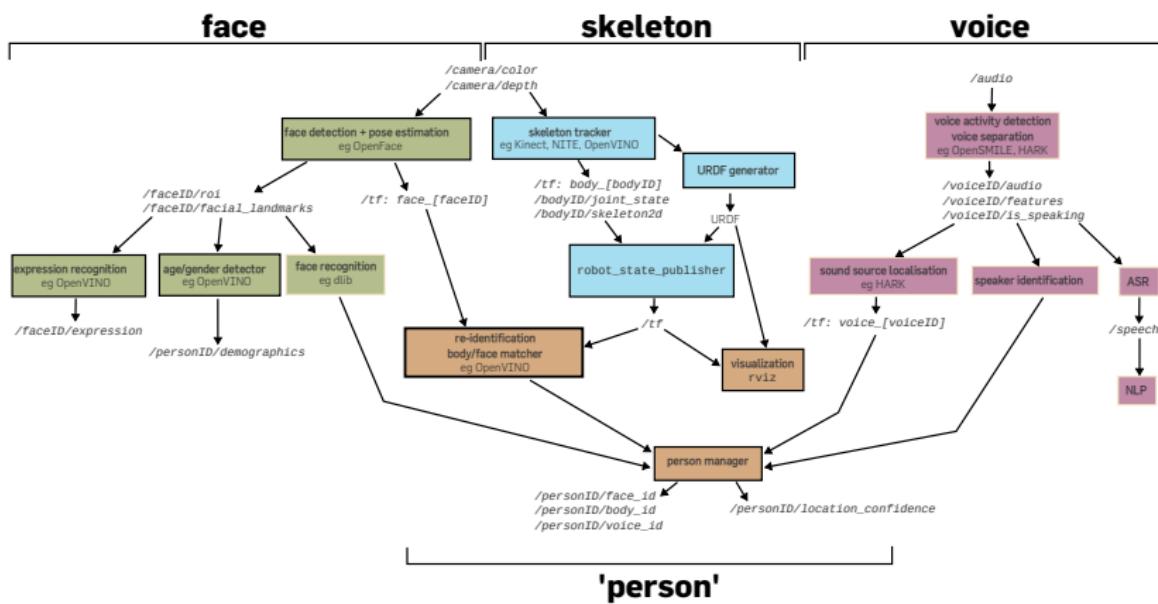
ARCHITECTURE FOR SOCIAL & AUTONOMOUS INTERACTION



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



SOCIAL SIGNAL PROCESSING PIPELINE



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

REAL-WORLD SOCIAL AUTONOMY

Main contributions:

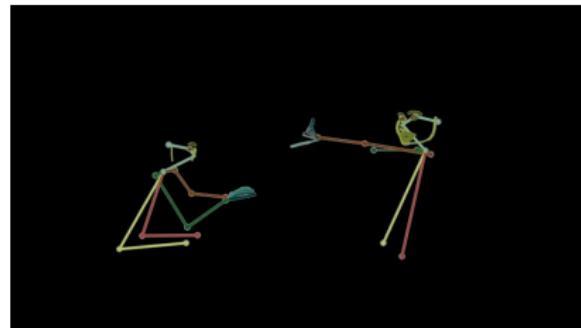
1. state-of-art **cognitive architecture for social interaction**
2. framing **semantic-aware robotic architectures**
3. large-scale, multi-modal, standard-compliant **social signal processing**

Impact:

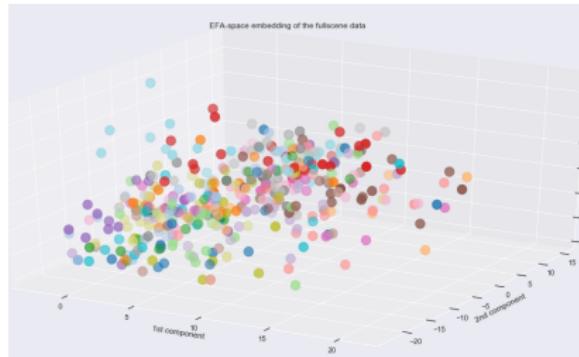
- major publications, incl. *Artificial Intelligence*, *HRI*, *IROS*; 800+ citations
- 2nd most cited paper ever from *Artificial Intelligence*
- major contribution to open-source robotics; 150+ GitHub repos

3. DATA-DRIVEN HRI

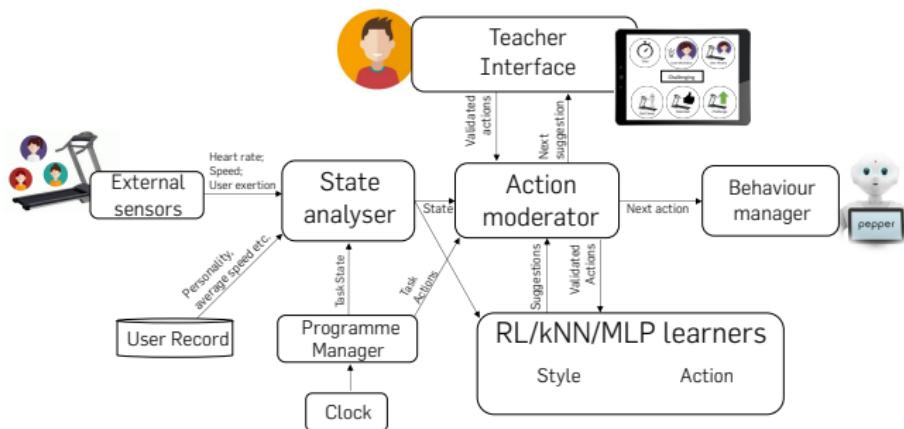
LARGE SCALE DATASET OF SOCIAL INTERACTIONS



- 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



SPARC: 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

Main contributions:

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

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

4. HUMAN FACTORS

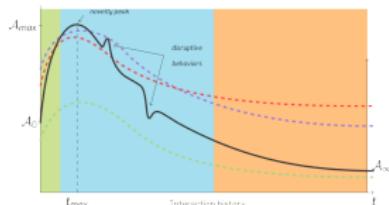
EXPERIMENTAL WORK

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



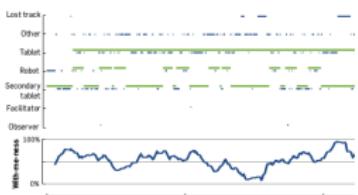
Understanding interaction



Robots for Learning



Methodology



SOCIAL ROBOTICS AND HUMAN FACTORS

Main 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:

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

RESEARCH PROJECT

How to push the state-of-the-art in social robotics?

- open, underspecified situations; rich semantics
 - better spatio-temporal semantic modeling
- complex social dynamics
 - **social situation assessment**
- diversity of tasks; long term, sustained interactions
 - **goal-driven, non-repetitive behaviours**

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- open, underspecified situations; rich semantics
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 - **social situation assessment**
- diversity of tasks; long term, sustained interactions
 - **goal-driven, non-repetitive behaviours**
- social acceptability
- responsible AI
 - **public-in-the-loop** research

Bio
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1. Symbolic social cognition
ooo

2. Real-world social autonomy
oooo

3. Data-driven HRI
oooo

4. Human factors
oooo

Research project
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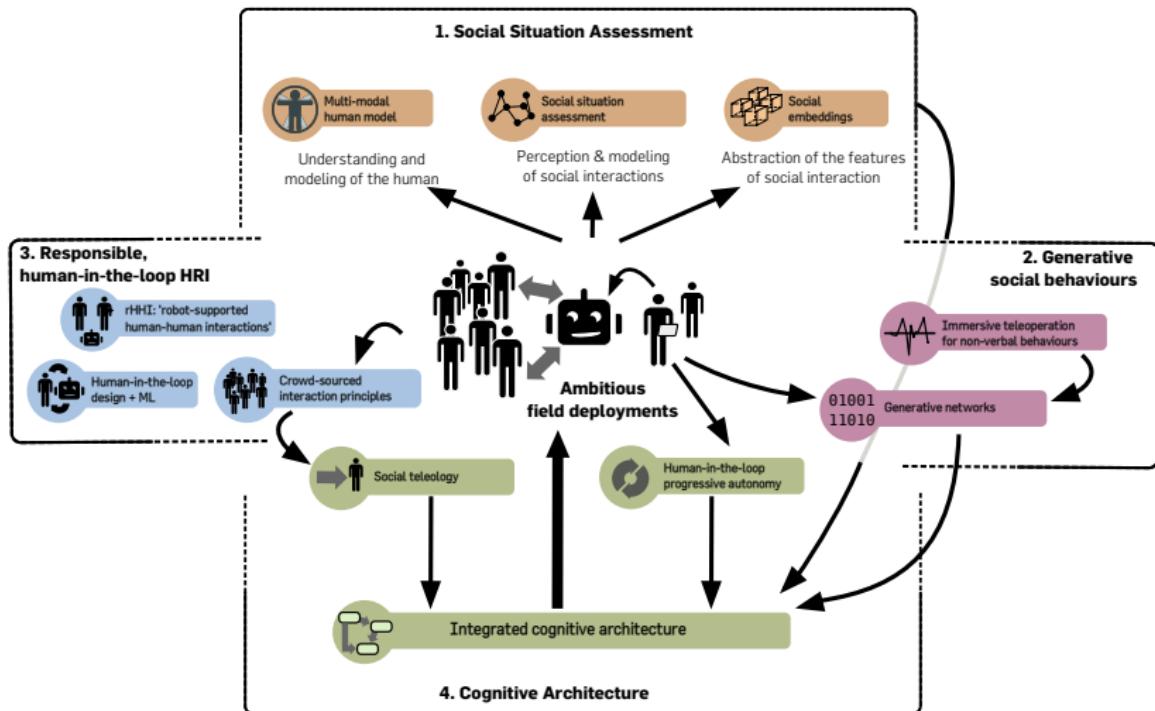
MY RESEARCH PROJECT

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

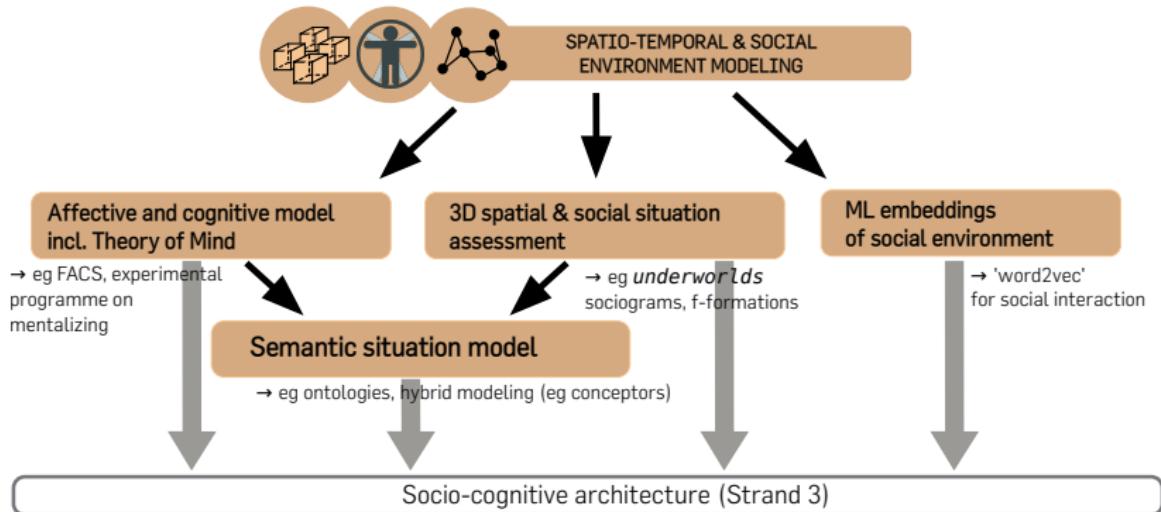
**Understand the dynamics of long-term social
human-robot interactions;**

**Create and sustain responsible, real-world autonomous
interactions with robots**

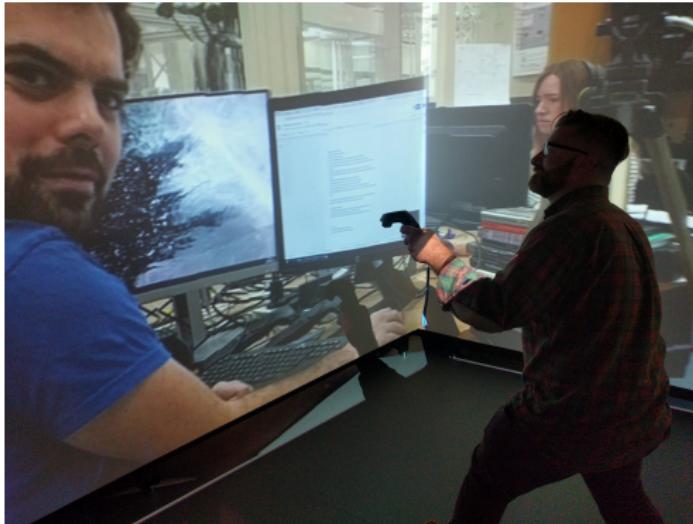
RESEARCH PROGRAMME



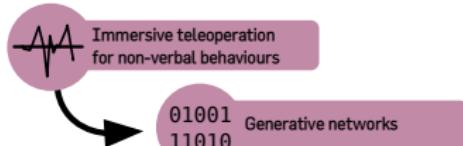
1. Social Situation Assessment



- SotA machine learning: **attention nets; deep graph nets**
- **Social embeddings**: learn an encoding of social interactions
- **hybrid pipeline**: eg *conceptors* to build symbolic models from neural nets
- real-world **robustness**: algorithmic redundancy; soft. eng. expertise (going beyond throw-away research code)

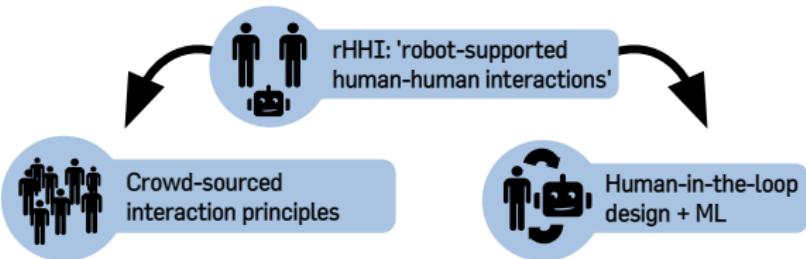


2. Generative social behaviours



- Cracking the '**non-repetitive, socially congruent**' behaviour generation problem
- Extend **Generative Adversarial Networks à la AppGAN** to complex behaviours (re-use *social embeddings*)
- **Immersive technologies** to build datasets
- **Transdisciplinary approach**, incl. arts: choreographer, sound expert

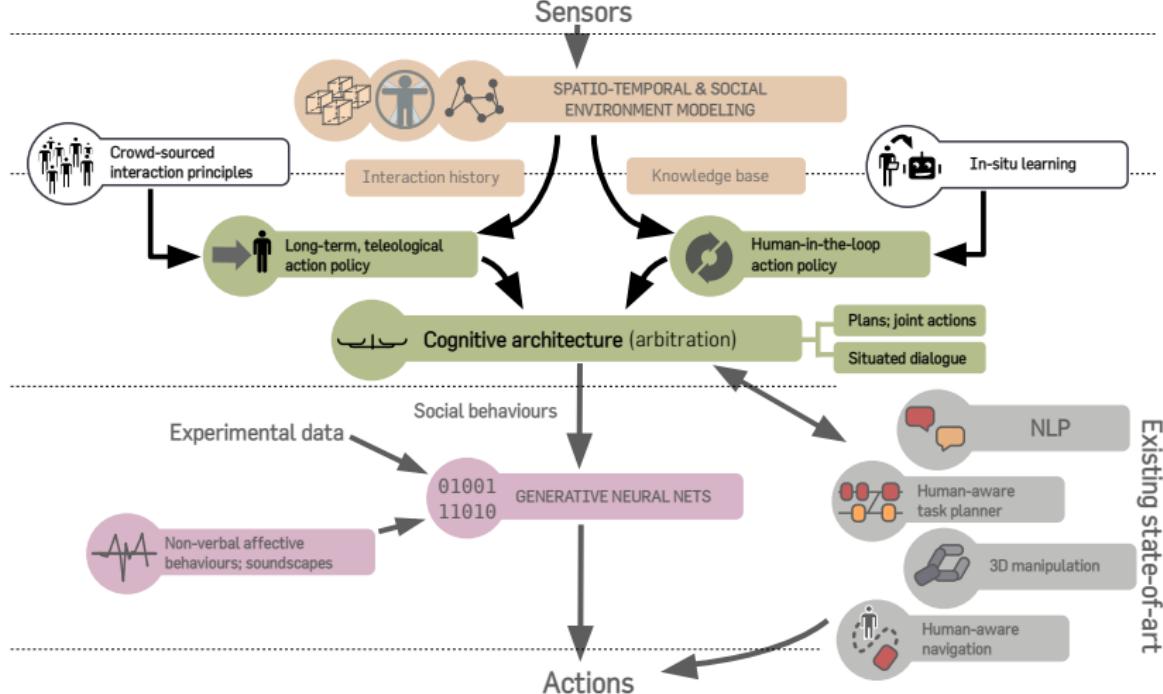
3. Responsible, human-in-the-loop HRI



1. interactive reinforcement learning
 - how to scale it to multiple tasks?*
 - how to deal with non-trivial semantics?*
2. intrinsic social motivation
 - large-scale public engagement to **co-design interaction principles: meaningful & useful social goals**
3. responsible AI
 - crowd-sourcing social norms** for human-robot interactions

→ shift from human-robot interactions to **robot-supported human-human interactions**

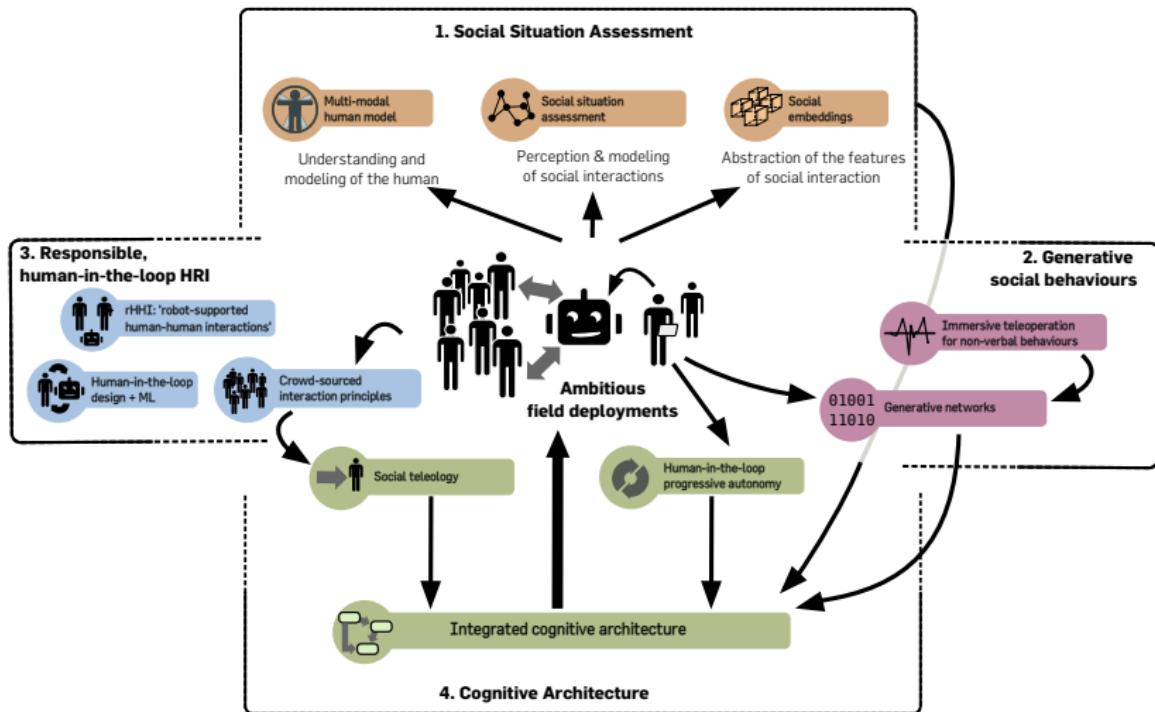
4. Cognitive Architecture



Main challenge: arbitration between **intrinsic social motivation** (teleologic architecture), **bottom-up human policies** (human-in-the-loop machine learning), and **top-down human-aware task planning**.

New research question! one lead: **experience transfer in RL**

RESEARCH PROGRAMME



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

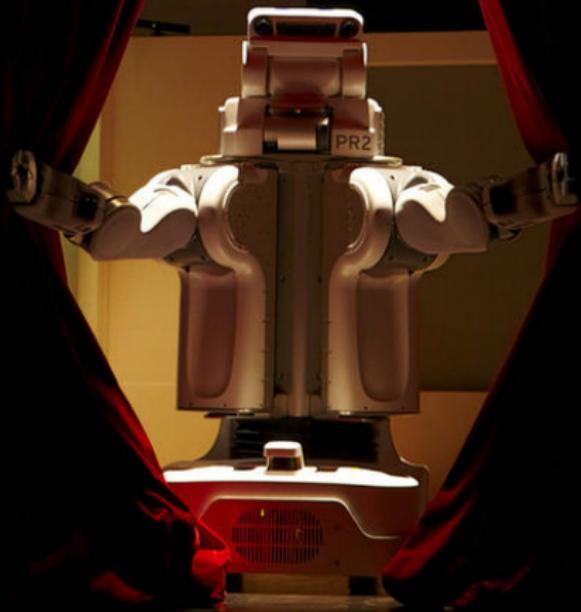


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What I would bring:

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

Thank you!



(picture from roboscopie, a theatre play I 'programmed' with director Nicolas Darrot in 2012)