CNRS Research Project

Pr. Séverin Lemaignan

Academic track record and contributions

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Academic profile

Since I completed my joint PhD in Cognitive Robotics from the CNRS/LAAS (France) and the Technical University of Munich (Germany), for which I received the GdR Robotique *Best PhD in Robotics 2012* award from French CNRS and the prized *Cumma Summa Laude* distinction in Germany, I have emerged as a rising leader in HRI.

Soon after my PhD, I created and successfully led for 2 years a HRI research group within the AI for Learning CHILI Lab at EPFL (Switzerland). While my original training was in **symbolic cognition & AI for autonomous robotics**, my postdoctoral stay at the highly cross-disciplinary CHILI Lab gave me the opportunity to become an expert in **child-robot interaction** and **robotics for learning**, while providing me with a solid footing in **experimental sciences, socio-psychology and education sciences**.

I was then awarded an EU **H2020 Marie Sklodovska-Curie Individual Fellowship** and I engaged in basic research on artificial cognition at the University of Plymouth, UK: over 2 years, I explored the **underpinnings of artificial social cognition**. I **contributed significantly to the framing of the emerging field of data-driven HRI**, also releasing the PInSoRo open dataset [1], a one-in-a-kind dataset of natural child-child and child-robot social interactions.

I join the Bristol Robotics Lab (BRL, largest co-located robotic lab in the UK) in 2018, first as a Senior Researcher, and since 2019, as a permanent **Associate Professor in Social Robotics and AI**. I am **in charge of defining and implementing the lab's research strategy in human-robot interactions**, and my field of expertise covers **the socio-cognitive aspects of human-robot interaction, from the perspective of human cognition, social signal processing and the design and implementation of cognitive architectures for robots**. I focus my **experimental work on real-world, natural human-robot interactions**, with a particular interest on **child-robot interactions in educative settings**, exploring how robots can support teachers and therapists to develop engaging novel learning paradigms.

I detail my main scientific and technical contributions to date in the *Scientific and technical contributions* section, below.

Significant awards

HRI'2017	Best Paper award
HRI'2016	Best Paper award
AAAI'2015	Best Video award in Artificial Intelligence
HRI'2014	Best Late Breaking Report award
2012	GdR Robotique **Best PhD in Robotics 2012** award, CNRS, France
2012	PhD with **High Distinction** ("Summa Cum Laude"), TU Munich
Ro-Man'2010	Best paper award

Significant fellowships and grants

2020	**Submission of an ERC Consolidator** fellowship (unsuccessful)
2020	PI **robots4SEN** project, UWE VC Grand Challenges, £30K
	$\rightarrow$ *deployment of autonomous robots in a school for autistic children*
2019	UWE Vice Chancellor Accelerator Fellowship
2018	Co-I **CAV Forth** project, Innovate UK, £5M
	$\rightarrow$ *first paying-service deployment of an autonomous bus in Scotland*
2015 – 2017	**EU Marie Skłodowska-Curie Individual Fellowship**
	$\rightarrow$ *Theory of Mind and social robotics, Plymouth University, UK*

Scientific and technical contributions

Over the twelve years of my research career, my main contributions to science are:

1. **a pionnering work on *symbolic knowledge representation* and *semantic-aware decisional architecture* for interactive robots;**
2. **a key role in the development of *situation assessment*, and more recently, *social situation assessment*, as the formal investigation of the models required by robots to achieve autonomy in human environments;**
3. **a key role in bridging research in cognitive psychology and sociology with robotics, with a number of cross-disciplinary literature surveys and experiments;**
4. **a major contribution to the field of child-robot interaction, in particular by studying the importance of a *social* interaction between the child and the robot;**
5. **a leading role in the recent development of *data-driven human-robot interaction*, via for instance the acquisition of large datasets, and the development of novel 'human-in-the-loop' machine learning algorithms.**

In addition to these scientific contributions, I have led a number of efforts on the methodology and technical tools used in human-robot interaction, and more broadly, in robotics, through targeted publications and numerous open-source contributions.

This section contextualises all these contributions, and presents the impact of my research through a selection of my main scientific outputs.

My scientific contributions cover three main research directions: **Knowledge representation and cognitive architectures**, **Social Robotics** and **Data-driven Human-Robot interactions**. I detail each of those, as well as my main methodological and technical contributions, in the following subsections.

Table 1 gives an overview of my scientific fields of contribution, focusing on those which are directly relevant to the research programme I propose to conduct at CNRS.

My research on these topics has resulted in a substantial track record of academic outputs.

Since 2008, I have authored or co-authored **75+ peer-reviewed publications** in international journals and conferences, leading to **2700+ citations**, h-index of 26, i10-index of 43 (source: Google Scholar).

Table 1: PI's domains of expertise relevant to the research project

Psycho-social underpinnings of HRI	
human factors	anthropomorphism[2], cognitive correlates[3], social influence[4]
trust, engagement, social presence	[5][6][7][8][9]
theory of mind	perspective taking[10, 11], social mutual modelling[12, 13]
Social signal processing	
non-verbal behaviours	attention[14], child-child dataset[15], internal state decoding[16]
verbal interactions	speech recognition[17], dialogue grounding[18]
Behaviour generation	
social behaviours	[19], verbal interactions[20, 21], physical interactions[22]
interactive reinforcement learning	[23, 24, 25, 26]
Socio-cognitive architectures	
architecture design	[27, 28, 29, 30, 31]
knowledge representation	ontologies [32, 33]
spatio-temporal modelling	object detection [34], physics-aware situation assessment[35, 36]
Fieldwork in HRI	in classrooms [37, 38, 39, 40, 41, 42], at home [43], in public spaces [26]

Knowledge representation and cognitive architectures

My early research focused on investigating how high-level symbolic reasoning could benefit human-robot interaction. My main insight was to bridge the research performed in the Semantic Web community (that I had already researched during my MSc [44]) with robotics, integrating **ontologies** into the robot's decisional architecture [32] (see box below). This work, that I developed between LAAS-CNRS (Pr. Alami) and the Technical University of Munich (Pr. Beetz), has had a large impact in AI for interactive robots, **bridging low-level robot perceptions and commands, to human-level semantics**.

Lemaignan, S., Ros, R., Mösenlechner, L., Alami, R., Beetz, M.
ORO, a Knowledge Management Module for Cognitive Architectures in Robotics
IEEE IROS 2010

One of the very first knowledge base designed and integrated in service robots. Pioneering work which played a key role in understanding how intelligent robot can represent their knowledge to facilitate communication with humans.
[Contribution: principal investigator; 177 citations to date]

One of the most significant application of this work has been on **natural language understanding**: by relying on ontologies with human-level semantics to annotate information flows in the robot's decisional layers [33], **establishing a semantic common-ground with a human user was greatly simplified**, as I show in [18] (see box below) and in eg [45].

Lemaignan, S., Ros, R., Sisbot, E. A., Alami, R., Beetz M.
Grounding the Interaction: Anchoring Situated Discourse in Everyday Human-Robot Interaction
Intl Journal of Social Robotics 2012

In this paper, I develop a natural language parser and I show how symbolic knowledge representation can be used by robot to ground natural language interactions, also taking into account the unique perspective of the human interactor.
[Contribution: principal investigator; 110 citations to date]

I then integrated this work on knowledge representation and manipulation into a much larger **semantic-aware architecture**. I led the design of this architecture, to which a number of additional cognitive and manipulation capabilities designed by colleagues, were added (including eg 3D manipulation, human aware navigation and task planning). To date, the resulting system [27] (see box below) is still **one of the very few complete robotic architecture enabling high-level human-robot interaction**.

Lemaignan, S., Warnier, M., Sisbot, E.A., Clodic, A., Alami, R.
Artificial Cognition for Social Human-Robot Interaction: An Implementation
Artificial Intelligence 2017

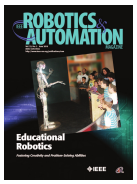
Landmark article: one of the first complete, semantic-aware, robotic architecture for human-robot interaction, including symbolic knowledge representation, situation assessment, natural language grounding, task planning, human-aware motion planning and execution.
[Contribution: principal investigator & coordinator; 210 citations to date]

Social robotics and child-robot interaction

From 2012 onwards, and building on my research on semantic-aware human-robot interaction, I shifted my scientific focus to the **social aspects of the interaction**, with a particular emphasis on the **psycho-social underpinnings of social interaction with robots**. This work started with an investigation of perspective taking, and what is called 'mentalizing' in psycho-linguistics (the cognitive ability to model what others know about the word, a key pre-requisite of interaction). This led to several publications [10, 11, 12] and I was awarded in 2015 a EU H2020 Marie-Sklodovska Curie fellowship to specifically investigate this question.

I also investigated a range of other psycho-social determinants, with significant work on anthropomorphism [3, 7, 46, 6] (I supervised J. Fink who did her PhD on this topic), trust and engagement [5, 6, 7, 9], or social influence [8, 4] (topic of K. Winkle's PhD).

[47]



Lemaignan, S., Jacq, A., Hood, D., Garcia, F., Paiva, A., Dillenbourg, P.

Learning by Teaching a Robot: The Case of Handwriting

Robotics and Automation Magazine 2016

Long-term studies with children and therapists, where we *reverse* the social role of the robot to significantly improve the children' self-confidence. A landmark contribution to social robotics for education.

[Contribution: principal investigator; 179 citations (incl. conf. article)]

Wallbridge, C., Lemaignan, S., Senft, E., Belpaeme, T.

Generating Spatial Referring Expressions in a Social Robot: Dynamic vs Non-Ambiguous

Frontiers in AI and Robotics 2019

Challenges the common understanding that robots should be unambiguous: we show that ambiguity is often desirable for fluid and natural human-robot interactions. **[main study supervisor]**

Lemaignan, S., Sallami, Y., Wallbridge, C., Clodic, A., Alami, R.

UNDERWORLDS: CASCADING SITUATION ASSESSMENT FOR ROBOTS

IEEE IROS 2018

A novel representation technique to efficiently represent multiple parallel states of the world, including imaginary ones. This ability is critical to represent spatio-temporal predictions, and to create models of other agents' representations. **[principal investigator]**

Data-driven Human-Robot Interaction

Senft, E., Lemaignan, S., Baxter, P., Bartlett, M., Belpaeme, T.

Teaching robots social autonomy from in situ human guidance

Science Robotics 2019

A novel human-in-the-loop machine learning approach to implement social autonomy in a robot, with several deployments in UK public schools. This is a first-in-kind demonstration of learning autonomous action policy in a high dimensional, socially complex, environment. **[main study supervisor]**

Bartlett, M., Edmunds, C. E. R., Belpaeme, T., Thill, S., Lemaignan, S. **What Can You See? Identifying Cues on Internal States from the Kinematics of Natural Social Interactions**

Frontiers in AI and Robotics 2019

Investigates how partially hidden 'internal states' (like emotions, cooperativeness, etc) can be decoded from simple visible cues, like skeletons. Also demonstrates that social situations can be described along 3 simple dimensions. **[main study supervisor]**

Lemaignan, S., Edmunds E. R., C., Senft, E., Belpaeme, T.

The PInSoRo dataset: Supporting the data-driven study of child-robot social dynamics

PLOS ONE 2018

A first-in-kind, large scale dataset of child-child and child-robot social interactions. Design with machine learning in mind, this dataset effectively opens up the field of data-driven social psychology, with direct applications in AI and social robotics.**[principal investigator]**

Senft, E., Baxter, P., Kennedy, J., Lemaignan, S., Belpaeme, T.

Supervised Autonomy for Online Learning in Human-Robot Interaction

Pattern Recognition Letters 2017

The mathematical and technical bases of the SPARC paradigm for human-in-the-loop machine learning, showing that high-dimensional problems can be learnt effectively and rapidely thanks to an innovative input feature selection mechanism. **[student supervisor; 22 citations]**

Methodological contributions

[48] [8] [41] [17]

Fieldwork in HRI in classrooms [37, 38, 39, 40, 41, 42], at home [43], in public spaces [26]

Technical contributions

Since 2010, I have made a number of significant technical contribution to the field. I have always adopted a open-science approach, releasing all of my software contributions to the wider community under open-source licenses.

I list hereafter my most significant technical contributions (typically the one with an associated publication), followed by additional noteworthy technical contributions.

- the `oro` knowledge base [32] – this highly cited work introduced the usage of ontologies (and associated techniques like semantic reasoning) in robotics.
- the natural language processing with semantic grounding tool `dialogs` [18] – this other highly-cited tool demonstrated how natural language and interactive semantic learning could be realised by combining semantic reasoning with advanced human perception.
- the `MORSE` simulator [49, 50], one of the very first simulator enabling human-robot interaction simulation, and used by tenths of universities worldwide since its inception.
- the GenoM verifiable software module generator [31] – this tool makes it possible to abstractly specify a robotic module, and automatically generate a code skeleton whose behaviour can be proven correct.
- the Python-based `pyRobots` asynchronous supervision framework [51] – adapted some of the concepts orginally created in the URBI language to Python, making it possible to easily write asynchronous supervisors for robots using eg ROS.
- integration of the LAAS architecture for social robots [27] – I coordinated the effort of a large team of researchers at LAAS to integrate a significant number of software modules in a coherent architecture for social interaction. One of my most-cited paper.
- a high-accuracy 2D localisation method based on structured patterns [52] – I supervised this work in which we attempted to address the difficult issue of high-accuracy indoor localisation in complex, highly-occluded environment. Our method, which relies on decoding structured patterns placed in the environment, allows for sub-mm localisation with very low computational cost (can fully run on a microcontroller)
- the 3D situation assessment platform `underworlds` [35] – this tool is a distributed scene-graph, making it possible to maintain a joint dynamic 3D model of environment across software modules. It features sensor fusion, and spatial reasoning capabilities like perspective taking.
- a new algorithm for interactive reinforcement learning [24] – the algorithm, developed by one of my student, has enabled for the first to to teach a robot both a task and a social action policy *while being in use in the field*. We were able to show that after a short training phase, the robot was able to reach fully autonomy on a complex educative task.

In addition to these academic outputs, other significant technical contributions include:

- **The port to Python3 of the Robot Operating System (ROS)**, the large software framework used by the vast majority of the robotics community worldwide
- The **ROS4HRI** suite of software module to streamline complex human-robot perception pipelines (pre-print: [53])
- a multi-player online game to simulate human-robot interactions, used for teaching and research (eg online studies)
- The initial support of the widely used Softbank Nao robot to ROS (this work was later officially endorsed by Softbank, ex. Aldebaran Robotics), as well as the HOAP-3 humanoid robot
- a review of object recognition techniques [34],
- a number of tutorials and lectures on software engineering for robotics.

Contributions to the development of individuals

While at the 'AI for Learning' CHILI Lab at EPFL, I created and successfully led for 2 years the HRI resesarch group, supervising in total 10 students (including 4 PhD students with whom I co-authored a total of 18 papers). Within that short timeframe, I established CHILI as an internationally recognised research lab in robotics for education.

Then, during my EU Marie Skłodowska-Curie post-doc at Plymouth University, I further co-supervised 3 PhD students (co-authoring 17 publications with them).

My current role as a permanent **Associate Professor in Social Robotics and AI** at the Bristol Robotics Laboratory (BRL, largest co-located robotic lab in the UK) recognise my leadership. I am **in charge of defining and implementing the lab's research strategy in human-robot interactions**. I created the Embedded Cognition for Human-Robot Interactions (ECHOS) research group, that I now co-lead, supervising 15+ PhDs and post-docs. I also supervise the BRL's Connected Autonomous Vehicles research group (5 students and post-docs). Specifically, the ECHOS group covers most aspects of situated AI for human-robot interaction, **my role includes strategic planning of the group activities, scientific guidance, recruitment of staff and prospective students, and grant applications**.

Supervision of graduate students and postdoctoral fellows

2018 – 2019	**2 post-docs**, **5 PhDs**, **4 MSc students**, Bristol Robotics Lab, UWE, UK
2015 – 2018	**3 PhDs**, Plymouth University, UK
2013 – 2015	**5 PhDs**, **5 MSc students**, EPFL, Switzerland
2012 – 2013	**2 MSc students**, LAAS-CNRS, France

Teaching activities

2019 –	**Associate Professor** teaching at postgraduate level, UWE, UK
2018 – 2019	**Senior Lecturer** teaching at postgraduate level, UWE, UK
2015 – 2018	**Lecturer** teaching at undergraduate & postgraduate levels (robotics fundamentals, software engineering, human-robot interaction), Plymouth University, UK
2013 – 2015	**Teaching Assistant** teaching at undergraduate level (Visual Computing), EPFL, Switzerland
2008 – 2012	**Teaching Assistant** teaching at undergraduate level (programming, databases, ontologies), INSA Toulouse, France

Contributions to the wider research community

Since my PhD, I have established strong peer recognition in the field of human-robot interaction and cognitive robotics. This includes:

- numerous **invited talks** at national and international symposiums and events (9 invited talks since Jan. 2018, including **keynotes** at the UK Robotics and Autonomous Systems 2019 conference, and at the 2018 AAAI Fall Symposium);
- invited to **high-profile editorial roles**: Programme Committee member of the HRI conference since 2015; editor of Frontiers In Robotics and AI journal; editor or Programme Committee member of several leading conferences in AI and Robotics (RSS, IROS, IJCAI, HAI, AAMAS);
- invited member of the UK EPSRC Peer Review College; member of the EU H2020 peer review college; invited reviewer for the French, Dutch, Israeli research agencies;
- active role (organisation committee and/or programme committee in major conferences in robotics and AI (eg IEEE IROS, RSS, IEEE/ACM HRI, IJCAI);
- six invitations to PhD defense committees over the last two years.

Organisation of scientific meetings

2021	**ACM/IEEE Human-Robot Interaction conference**, Student Design Competition chair, virtually held
2020	**ACM/IEEE Human-Robot Interaction conference**, 700+ participants, local chair, Cambridge, UK
2017	**ACM/IEEE Human-Robot Interaction conference**, 400+ participants, alt.HRI chair, Vienna, AT
2016	**2nd Intl. workshop on Cognitive Architecture for Social HRI**, 45 participants, programme chair, Christchurch, NZ
2014	**Intl. workshop on Simulation for HRI**, 35 participants, programme chair, Bielefeld, DE
2012	**Intl. workshop on MORSE and its applications**, 30 participants, programme chair, Toulouse, FR
2009	**Cognitive Sciences' Young Researchers Conference**, 150 participants, steering committee, Toulouse, FR

Institutional responsibilities

2019 –	Full member of the EPSRC Peer Review college
2017–	EU H2020 member on the Peer Review College
2019 –	Head of the Outreach cluster, Faculty of Technology and Environment, UWE, UK
2019–	Invited PhD committee examiner (Örebro U., Uppsala U., KTH, Bielefeld U., LAAS-CNRS, BRL)
2018 –	HRI module co-lead, MSc level, University of the West of England, UK
2017 – 2018	Module leader, Robotics fundamentals (undergraduate level), University of Plymouth, UK

Editorial activities

2019 –	Member of the Robotics, Science and System (RSS) Programme Committee
2018 –	Editorial board of *Frontiers in AI and Robotics*
2017 –	Member of the IJCAI Programme Committee
2015 – 2020	Member of the IEEE/ACM HRI Programme Committee
2017 – 2019	Member of the IEEE IROS Programme Committee
2017 – 2018	Member of the HAI Programme Committee

Contributions to the broader society

I **actively engage with policy makers, at national and European level**: for instance, over the past 2 years, I have been directly interacting (through participating to panels, visits and one-to-one discussions) with the EU Research Executive Agency (MSCA AI Cluster 2019); the UK minister for Business, Energy and Industrial Strategy Greg Clark; the UK minister for Universities, Science, Research and Innovation Chris Skidmore; the chair of the West of England authority Tim Bowles; the UK Research & Innovation Portfolio manager for Robotics Clara Morri.

I have a **strong track record of tech transfer**, through patenting (US patent US20190016213A1) and involvement in national (UK) and EU-level projects focused on tech-transfer (InnovateUK ROBOPILOT, CAPRI, CAVForth; EU Terrinet, SABRE).

Finally, I actively engage in **research communication**: my past research has been covered several times by mainstream international media, including press releases by Reuters, Press Association; TV coverage by the BBC, Sky News; radio interviews and broadcast. My academic website (academia.skadge.org) showcases this media coverage. I also maintain an active, science-focused, presence on the social media (Twitter handle: @skadge).

Policy making

2020 –	**Expert Collaborator for the European Joint Research Centre** contributing to the UNICEF Guidelines for Responsible Child-Robots Interactions
2019	**Invited panel by the EU Research Executive Agency** at the 2019 MSCA AI Cluster, sharing expertise in Human-Robot Interaction

Technology transfer

2018 –	Co-I on UKRI InnovateUK projects ROBOPILOT, CAPRI, CAVForth, involving direct transfer of technology for automated verification of autonomous vehicles
2018 –	Scientific advisor for KickSum Ltd., in the frame of the EU-funded SABRE project
2018	Co-inventor on US patent US20190016213A1 on back-driveable, haptic locomotion for small robots

Selected outreach and public dissemination

2019–	Cluster Lead for STEM outreach, University of the West of England
2019–	Scientific advisor for the Bristol's Science Centre
2019	Hosted large media event for the Couch25K study [26]
2016–	UK & EU Robotics Weeks coordinator, University of Plymouth, University of the West of England
2015	Hosted large media event for the CoWriter study [38] (coverage by Reuters, BBC Arabic, FastCompany)
2011	'Roboscopie' Human-Robot public theater performance, Science Day'11 http://bit.ly/1LQpNWA
2008–2011	Toulouse's Cognitive Sciences Students Association, Co-chair
1997–2012	Executive Committee & Head of Educational Robotics, Planète Sciences (including coordination of the *EUROBOT* Robotic Competition)

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