



# Technical Committee on Cognitive Robotics

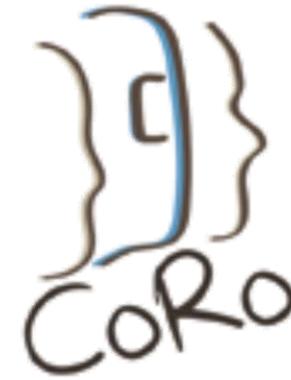
(TC-CoRo)

## Scope

There is growing need for robots that can interact safely with people in everyday situations. These robots have to be able to anticipate the effects of their own actions as well as the actions and needs of the people around them.



(Image courtesy of Fraunhofer IPA)



## MISSION

- to foster links between the fields of **robotics**, **cognitive science**, and **artificial intelligence**.
- make the field of cognitive robotics **industrially** and **socially** relevant.



## Co-Chairs



**Michael Beetz**  
*University of Bremen*  
*Bremen, Germany*



**G. Ayorkor Korsah**  
*Ashesi University*  
*Berekuso, E/R, Ghana*



**Jean Oh**  
*Carnegie Mellon University*  
*Pittsburgh, PA, USA*



**Tetsunari Inamura**  
*National Institute of*  
*Informatics Japan*



**Alessandra Sciutti**  
*Istituto Italiano di Tecnologia*  
*Genova, Italy*

## Emeritus Co-Chairs



**Giulio Sandini**  
*Istituto Italiano di Tecnologia*  
*Genova, Italy*



**Shingo Shimoda**  
*Riken Brain Science*  
*Institute Wako, Japan*

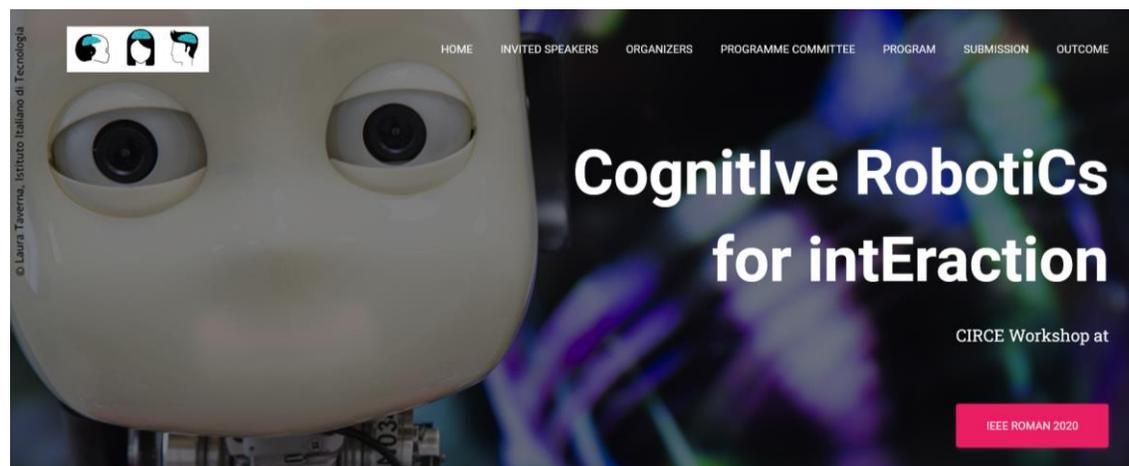
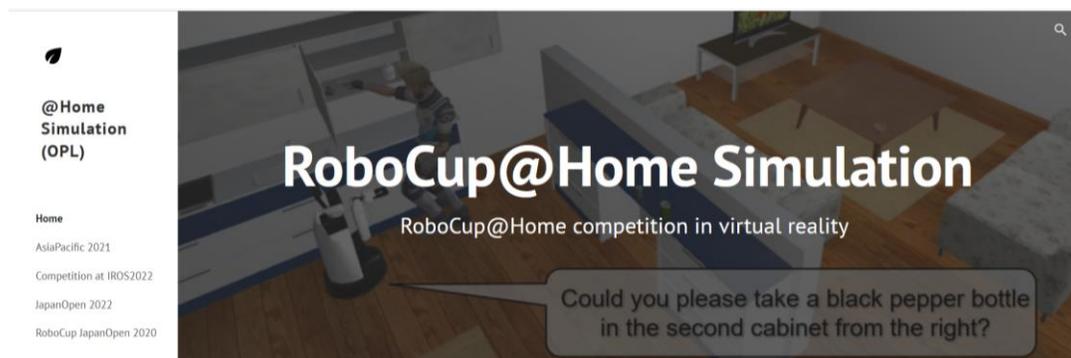


**David Vernon**  
*Carnegie Mellon University*  
*Africa Kigali, Rwanda*



# Workshop and Conference Organization

**27 workshops** organization and support at ICRA, IROS and outside RAS, to encourage interdisciplinary discussions



# Here at IROS 2022



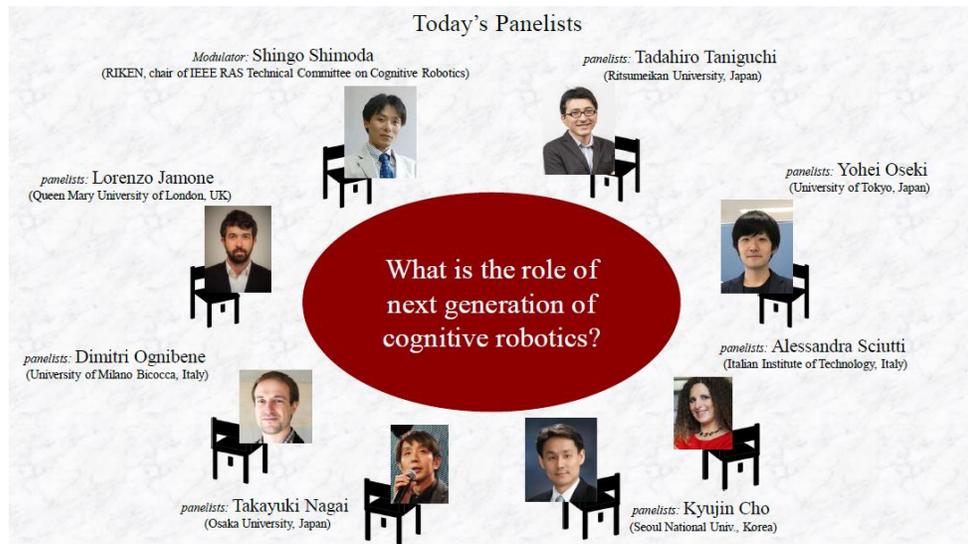
## ***WORKSHOPS AND COMPETITIONS***

1. [Interactive Service Robot Competition in Cyberspace](#) organized in conjunction with IEEE/RSJ IROS 2022.
2. [Behavior-driven Autonomous Driving in Unstructured Environments \(BADUE\)](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
3. [Ergonomic Human-Robot Collaboration: How Cognitive and Physical Aspects Come Together](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
4. [Robot Trust for Symbiotic Societies \(RTSS\)](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
5. [Social and Cognitive Interactions for Assistive Robotics \(SCIAR\)](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
6. [Workshop on Human Theory of Machines and Machine Theory of Mind for Human-Agent Teams \(TOM4HAT\)](#) at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
7. [Artificial Intelligence for Social Robots Interacting with Humans in the Real World \(intellect4hri\)](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO
8. [Life-long Learning of High-level Cognitive and Reasoning Skills](#) workshop at IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022), endorsed by the TC CORO



# Exemplar activity

Open on-line round table:



Organized by **Shingo Shimoda** on December 21<sup>st</sup> 2020 with TC members as panelists.

The discussion ranged from the **basic skills for cognitive functions** to the **implementation in the real world.**

The whole discussion is available online at <https://youtu.be/Q7dMo4dQqKw>

Review paper:

ADVANCED ROBOTICS  
2022, VOL. 36, NOS. 1–2, 3–16  
<https://doi.org/10.1080/01691864.2021.2011780>



SURVEY PAPER

OPEN ACCESS [Check for updates](#)

## What is the role of the next generation of cognitive robotics?

Shingo Shimoda<sup>a</sup>, Lorenzo Jamone<sup>b</sup>, Dimitri Ognibene<sup>c</sup>, Takayuki Nagai<sup>d</sup>, Alessandra Sciutti<sup>e</sup>, Alvaro Costa-Garcia<sup>a</sup>, Yohei Oseki<sup>f</sup> and Tadaihiro Taniguchi<sup>g</sup>

<sup>a</sup>RIKEN Center for Brain Science TOYOTA Collaboration Center, Nagoya, Japan; <sup>b</sup>School of Electronic Engineering and Computer Science, Queen Mary University of London, London, UK; <sup>c</sup>Computer Science and Artificial Intelligence, University of Milano Bicocca, Milano, Italy; <sup>d</sup>Graduate School of Engineering Science, Osaka University, Osaka, Japan; <sup>e</sup>Cognitive Architecture for Collaborative Technologies Unit, Italian Institute of Technology, Genova, Italy; <sup>f</sup>Department of Language and Information Sciences, University of Tokyo, Tokyo, Japan; <sup>g</sup>Department of Human and Computer Intelligence, Ritsumeikan University, Shiga, Japan

### ABSTRACT

Social demand for robots to be our partners in daily life has been rapidly increasing. Cognitive robotics should play a major role in making robots our partners. To discuss the role of cognitive robotics, we organized the round table in December 2020. This review paper aimed at clarifying the role of cognitive robotics summarizing the discussion in the round table. The round table noted that the existence of uncertainty in the continuous control loop is a source of the need for cognitive robots and is the key factor that distinguishes cognitive robotics from the cognitive system in other fields. This paper summarized the discussion focusing on the creation of several cognitive functions without stopping even if the robots face novel uncertainty in daily life. We discussed information generalization, active sensing, prediction, and language communication as the necessary functions for future cognitive robots. One of the conclusions of the discussion is the importance of setting primitive but concrete targets for cognitive robotics research as cognitive robotics problems. We should continue to discuss the setting of these targets as a grand challenge for cognitive robotics.

### ARTICLE HISTORY

Received 31 May 2021  
Revised 19 September 2021  
Accepted 16 October 2021

### KEYWORDS

Cognitive robot; information generalization; active sensing; prediction; language communication



Steering **IEEE Transactions on Cognitive and Developmental Systems (TCDS)** is an important contribution to encourage the discussions on cognitive robotics.

First impact factor in 2017: 1.952

In 2019: 2.755

Now risen to **4.546**

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# IEEE TRANSACTIONS ON COGNITIVE AND DEVELOPMENTAL SYSTEMS

A PUBLICATION OF THE IEEE COMPUTATIONAL INTELLIGENCE SOCIETY  
THE IEEE ROBOTICS AND AUTOMATION SOCIETY

## TCDS

- IEEE Transactions on Cognitive and Developmental Systems
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## Scope

The IEEE TRANSACTIONS ON COGNITIVE AND DEVELOPMENTAL SYSTEMS (TCDS) focuses on advances in the study of development and cognition in natural (humans, animals) and artificial (robots, agents) systems. It welcomes contributions from multiple related disciplines including cognitive systems, cognitive robotics, developmental and epigenetic robotics, autonomous and evolutionary robotics, social structures, multi-agent and artificial life systems, computational neuroscience, and developmental psychology. Articles on theoretical, computational, application-oriented, and experimental studies as well as reviews in these areas are considered.

TCDS is financially co-sponsored by the Computational Intelligence Society and the Robotics and Automation Society. TCDS is technically co-sponsored by the Computer Society.

### Impact Score

<b>4.546</b> Impact Factor	<b>0.00211</b> Eigenfactor	<b>0.857</b> Article Influence Score	<b>7.1</b> CiteScore <small>Powered by Scopus</small>
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## Organization and technical supports of IEEE International Conference on Development and Learning and on Epigenetic Robotics (ICDL)

ICDL targets not only robotics people but also the researchers in the field of psychology and human science, with the joint goal of **further understandings human development and learning systems, and of creating robots inspired by the human cognitive systems.**





# Courses and Schools

- The IEEE RAS CEMRA Program for Creation of Educational Material in Robotics and Automation supported the creation of an [introductory course on cognitive robotics](#) in 2020.
- Online course: Design and Implementation of Cognition-Enabled Robotic Systems. Michael Beetz, David Vernon, Joern Syrbe. On the German open KI Campus platform (<https://ki-campus.org/courses/cognitionrobot-ub2021?locale=de>)
- 2021 EASE Fall School for cognition-enabled robot manipulation (<https://ease-crc.org/fall-school-2021/>) (virtual school)
- 2022 EASE Fall School for cognition-enabled robot manipulation (<https://ease-crc.org/fall-school-2022/>)

KI-Campus BETA Lernangebote Themen Community Blog Über uns DE EN Registrieren Anmelden

KI-Campus-Original

## Design and Implementation of Cognition-Enabled Robotic Systems

Start: jederzeit  
Umfang: 10 weeks à 8 hours  
Sprache: Englisch

[Einschreiben / Zum Kurs](#)

## Cognitive Robotics



An introductory course for the IEEE Robotics and Automation Society Technical Committee for Cognitive Robotics



Instructors: send an [email](#) to request the complete set of PowerPoint slides. Example code is available on [Github](#).  
If you already have a copy, check the [Version History](#) to make sure you have the most recent version. If you don't, please send an email to request it.



A PR2 robot pours popcorn from a saucepan (left) and sets a table (right) during demonstrations of cognitively-enabled robot manipulation using CRAM. Image courtesy of the Everyday Activity Science and Engineering (EASE) interdisciplinary research center at the University of Bremen, Germany.

[Course Description](#) | [Learning Objectives](#) | [Content](#) | [Lecture Notes](#) | [Course Textbook](#) | [Recommended Reading](#) | [Software](#) | [Resources](#) | [Acknowledgements](#)

Everyday Activity Science & Engineering

EASE open EASE EASE Innovation EASE Academy EASE Learning Hub EASE openLab EASE Outreach

**EASE Fall School**  
Cognition-enabled Robot Manipulation

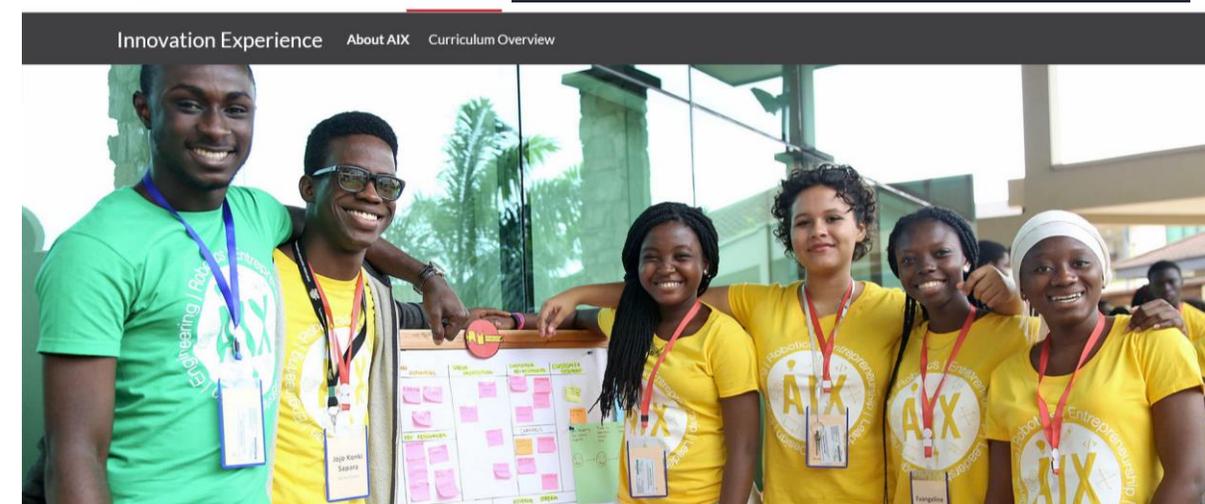
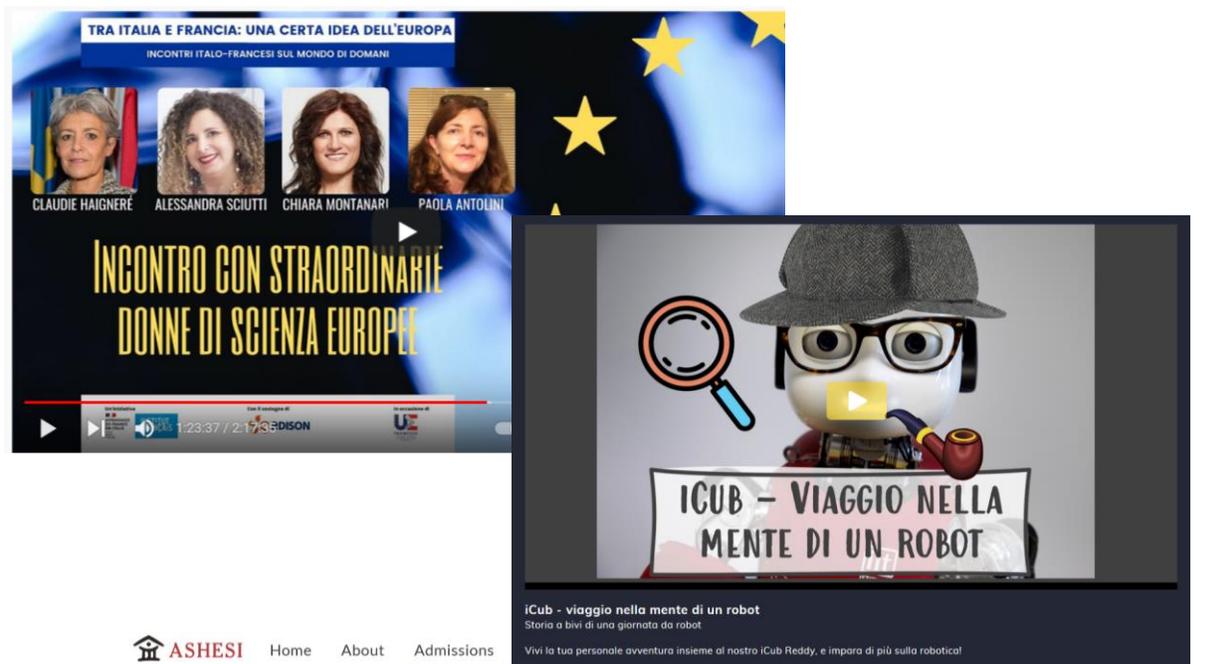
19 - 23 September 2022

DFG



# Dissemination activities to general public

- Free downloadable **educational children book** on cognitive robotics in the book series “Finja Finds it Out Again!!” and the title “the mysterious robot” for school pupils grades 3-6. The EASE center provides a free downloadable version in English and free class sets.
- The Ashesi Innovation Experience (<https://ashe.si/aix>) is a two-week enrichment programme we run annually at Ashesi University for **high school students** from across Ghana and other parts of Africa. It includes a one-week hands-on robotics workshop.
- Virtual activity “Trip in the mind of a robot” (in Italian), (<https://short.iit.it/contact>) a video adventure **for children and adults** providing insights on the actual capabilities of current robots with researchers’ explanations (first presented on Oct 2021)
- Invited webinar on **Promoting STEAM disciplines for girls** dedicated to **primary schools** of Regione Liguria organized by “Progettiamoci il futuro” and Regione Liguria, 8th March 2021 (Italian)
- Participation at the round table “Encounter with extraordinary European women in science” dedicated to **secondary school students** and organized by France Embassy and Institut français Italia. Rome, Italy, 11th February 2022. Also in streaming with about 2000 visualizations. <https://youtu.be/mU2JCi5pdsU?t=5037>

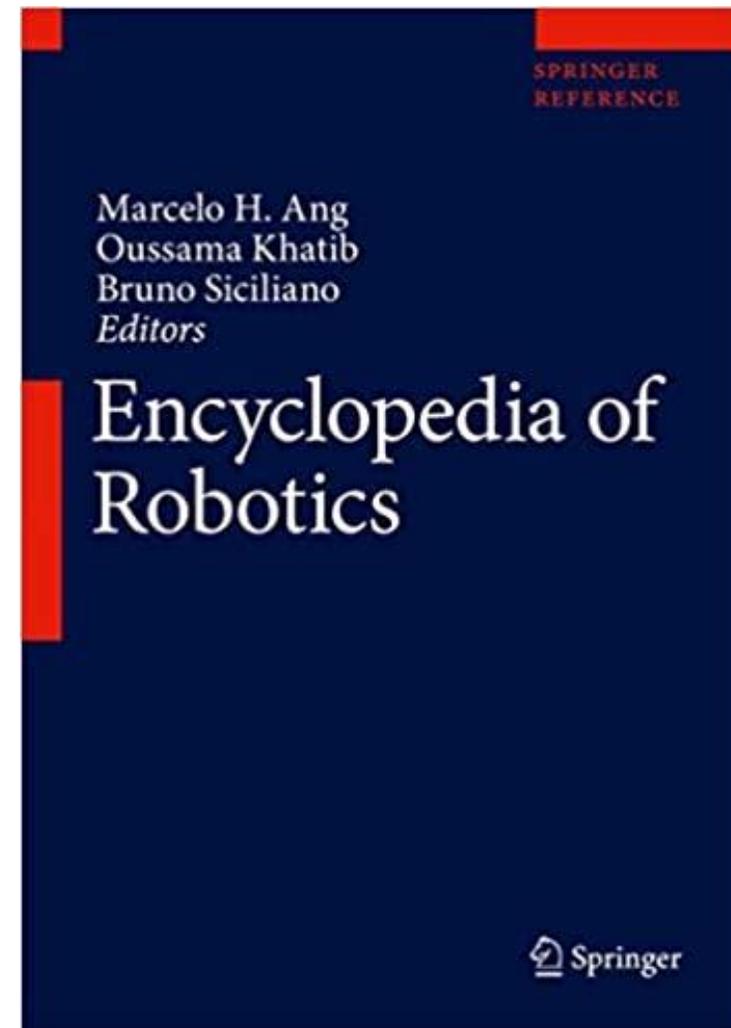
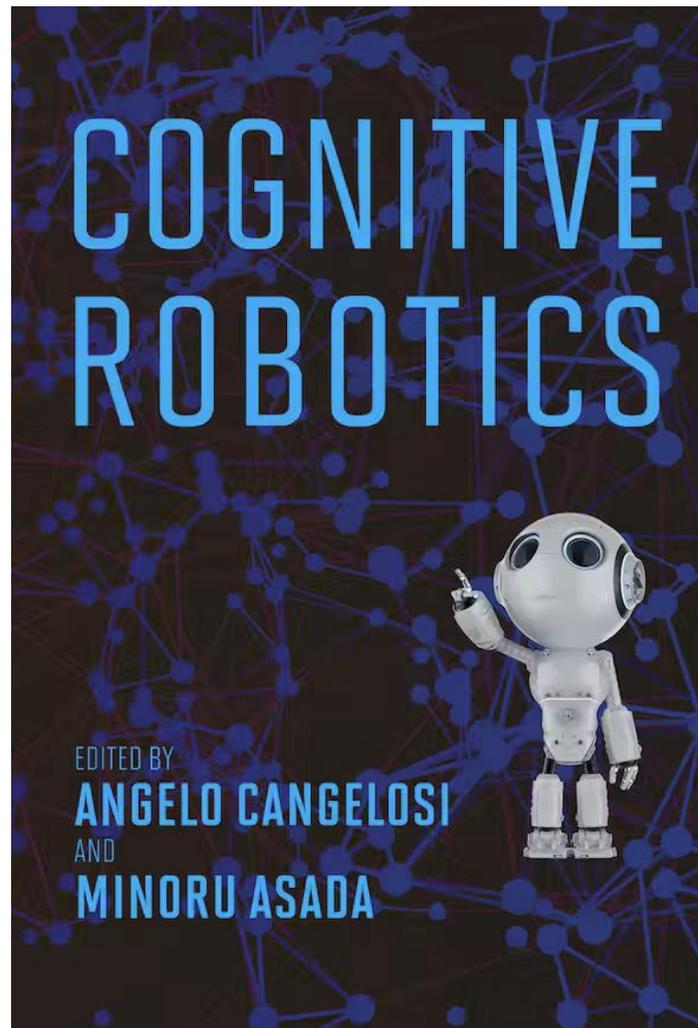




# Books and book chapters on cognitive robotics

**Important books and book chapters on cognitive robotics** have been published by the members of the TC and by the co-chairs in the past three years

(in particular Cangelosi, A. and Asada, M. (2021), Eds., *Cognitive Robotics*, MIT Press, with the chapter "Cognitive Architectures" by David Vernon; and the entry "*Cognitive Robotics*" by Sandini, G., Sciutti, A., and Vernon, D. (2021) in the *Encyclopedia of Robotics*, Ang, M., Khatib, O., Siciliano, B. (Eds.), Springer, Berlin, Heidelberg.)





# Plans for next years

**Challenge for cognitive robotics:**  
*show adaptivity and learning over **long-term interaction** with the environment and with human partners.*

- An **architectural view** of the robot cognition
- Enabling **prospection** and **internal simulation** and building a proper **memory** system.
- Enabling **dyadic** and **group interactions**

Addressing these challenges requires a **strong multidisciplinary participation**

Hence, we plan for the next three years to keep the discussion on these topics active, ideally across different disciplines, through **the support and the organization of events**, of dedicated **special issues** and the participation to **relevant initiatives**.

**euROBIN network of excellence unites Europe's leading research labs**

**University of Bremen Takes On Key Role in Robotics Network of Excellence**

The University of Bremen is a member of the European Robotics Excellence Network "euROBIN". Within the research network, which includes renowned research institutions and large industrial companies, it coordinates one of four scientific focal points.

27.07.2022  
Autor/in: Axel Kölling / Meike Mossig

EuROBIN is a network of excellence that brings together European robotics expertise and AI to establish a single pan-European platform for research and development. For the first time, a large

*Co-chair M. Beetz coordinates a focal point*

**iCog.**  
The iCub Cognitive Architecture

The Cognitive Architecture Initiative: iCog [www.icog.eu](http://www.icog.eu)

iCog is an open source initiative started at IIT with the goal of advancing our knowledge of human cognition by designing, building, and sharing a common cognitive architecture for an embodied artificial system such as iCub. The iCog cognitive architecture will provide a coherent baseline that will facilitate convergent, cumulative progress in the development of an operational model of cognition. In parallel iCog will facilitate experimental testing of core cognitive abilities and their dynamic and synergistic interplay as the robot interacts with its environment and other cognitive agents.

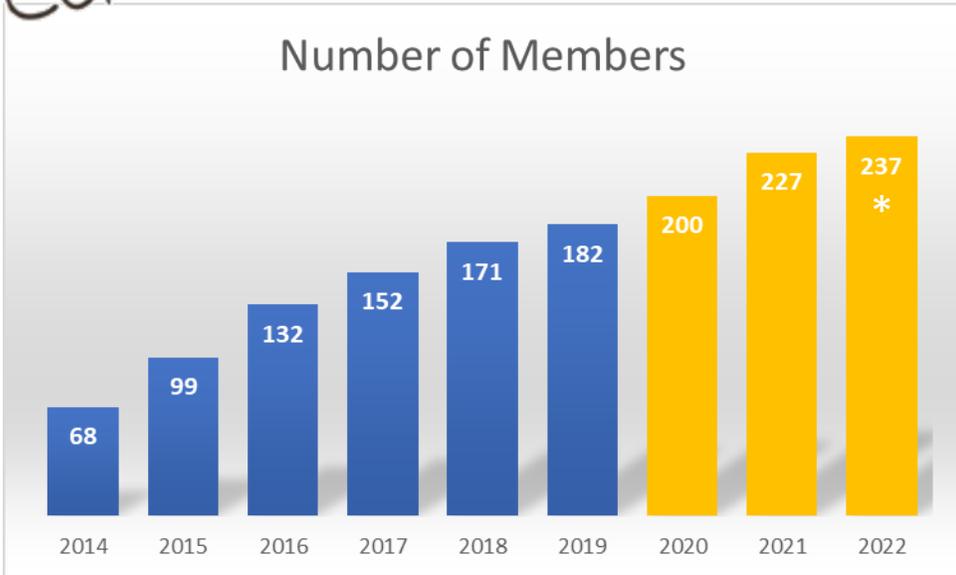
**An Open Initiative**

open source initiative open source hardware

*Coordinated by Emeritus Co-Chair: G. Sandini*



# Plans for next years



\* 230 + 7 under review

We will continue to update the **website**, but we will consider the opportunity to exploit also **different channels of communications** (such as twitter or instagram) to reach a wider audience.

Additionally, we will continue to moderate and handle **the mailing list**, which provides the members with the opportunity to exchange news and announcements on the TC topics.



## TECHNICAL COMMITTEE FOR COGNITIVE ROBOTICS

ACTIVITIES RESOURCES MEMBERS CONTACT JOIN US

### Resources

#### RESEARCH

##### Research Challenges

- Social Cognition for Human-Robot Symbiosis—Challenges and Building Blocks
- The limits and potentials of deep learning for robotics
- Building machines that learn and think like people
- Controversies in Cognitive Systems Research
- A First Draft Analysis of Some Meta-Re...

##### Cognitive Architecture Surveys

- 40 years of cognitive architectures: cor...
- Biologically Inspired Cognitive Architec...
- A world survey of artificial brain projec...

##### Cognitive Architecture Design Princ...

- Design principles for biologically inspir...
- Desiderata for Developmental Cognitiv...
- A Standard Model of the Mind, now rel...

##### Knowledge-based Approaches

- Ontology-based Approaches to Robot...
- Socio-physical Models of Activities (SO...



## TECHNICAL COMMITTEE FOR COGNITIVE ROBOTICS



ACTIVITIES RESOURCES MEMBERS CONTACT JOIN US

### Resources

#### Relevant Publications

- Shimoda, S., Jamone, L., Ognibene, D., Nagai, T., Sciutti, A., Costa-Garcia, A., ... & Taniguchi, T. (2022). What is the role of the next generation of cognitive robotics?. *Advanced Robotics*, 36(1-2), 3-16.
- Taniguchi, T., Yamakawa, H., Nagai, T., Doya, K., Sakagami, M., Suzuki, M., ... & Taniguchi, A. (2022). A whole brain probabilistic generative model: Toward realizing cognitive architectures for developmental robots. *Neural Networks*, 150, 293-312.
- Cangelosi, A. and Asada, M. (2021), Eds., *Cognitive Robotics*, MIT Press
- Sandini, G., Sciutti, A., and Vernon, D. (2021) "Cognitive Robotics" in *Encyclopedia of Robotics*, Ang, M., Khatib, O., Siciliano, B. (Eds.), Springer, Berlin, Heidelberg.
- Vernon, D. (2021). "Cognitive Architectures", in *Cognitive Robotics*, Cangelosi, A. and Asada, M. (Eds.), MIT Press.
- Ueda, S., Nakashima, R., & Kumada, T. (2021). Influence of levels of automation on the sense of agency during continuous action. *Scientific reports*, 11(1), 1-13.
- Di Cesare, G., Vannucci, F., Rea, F., Sciutti, A., & Sandini, G. (2020). How attitudes generated by humanoid robots shape human brain activity. *Scientific Reports*, 10(1), 1-12.
- Taniguchi, A., Hagiwara, Y., Taniguchi, T., & Inamura, T. (2020). Improved and scalable online learning of spatial concepts and language models with mapping. *Autonomous Robots*, 44(6), 927-946.
- Taniguchi, T., D. Mochihashi, T. Nagai, S. Uchida, N. Inoue, I. Kobayashi, T. Nakamura, Y. Hagiwara, N. Iwahashi, and T. Inamura. (2019). "Survey on Frontiers of Language and Robotics." *Advanced Robotics*, 33 (15-16), 700-730.
- Fischer, T., & Demiris, Y. (2019, issued in 2020). Computational modeling of embodied visual perspective taking. *IEEE Transactions on Cognitive and Developmental Systems*, 12(4), 723-732.

#### Top three technical innovations (2020-2022)

The top three outstanding innovations in Cognitive Robotics in 2020-2022 are:

1. Focus on an architectural approach to human - robot interaction to support autonomy and long-term interactions.
2. Advances in the integration of machine learning and model-based approaches in cognitive robots
3. Progress in language understanding and acquisition in real-world environments.



All-coro-tc

# Get in touch!

- Check the **website** to find the new events our members organize - <https://www.ieee-ras.org/cognitive-robotics/>
- **Tweet** with *#CognitiveRobotics* and *#TC\_CORO* when speaking of topics relevant for the Cognitive Robotics domain
- **Join** the TC and the **mailing list** to be updated
- **Write** to [alessandra.sciutti@iit.it](mailto:alessandra.sciutti@iit.it) your ideas/proposals on how the technical committee can help or support the field and your activities.