Proceedings of The Artificial Life Conference 2023

Edited by

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Preface

This volume presents the proceedings of ALIFE 2023, the 2023 Conference on Artificial Life, held in Sapporo, Japan, July, 24th-28th 2023 (http://2023.alife.org).

ALIFE 2023 marked an important milestone as the first hybrid conference since the onset of COVID-19. In the run-up to the pandemic, ALIFE 2019 had proactively integrated remote online conferencing into artificial conferences for the first time, a pioneering initiative largely driven by concerns about the carbon footprint of in-person scientific conferences. As the pandemic hit, it dramatically reshaped our everyday lives and forced us to adapt to a new way of living. Due to this, ALIFE 2020, ALIFE 2021, and ALIFE 2022 were held as virtual-only events, introducing a range of new platforms and activities tailored to remote-only conferences. As we moved into 2023, the severity of COVID-19 began to wane, and people started to return to their original lifestyles.

Nonetheless, our intention was not simply to revert back to the previous state of affairs. Consequently, ALIFE 2023 was organized as a hybrid event to capitalize on the advantages of both in-person and online participation. This approach was built upon the extensive experience gained from the past four editions of ALIFE conferences. While we made every effort to utilize this experience, we acknowledge that certain key issues still persist. For instance, the substantial time difference between local and online participants generally poses challenges for individuals from different groups.

As we reflect on the achievements of the past and embrace the challenges of the future, we thus humbly call upon the ALife community to further contribute your insights, experiences, and ideas to help shape the landscape of future ALIFE conferences. Your perspectives are invaluable, and it is your collective wisdom that will propel us forward on our quest to improve ALIFE conferences and, hopefully, unravel the mysteries of life.

The ALIFE 2023 Theme

The theme of this year's conference is 'Ghost in the Machine'. In the midst of AI's rapid and remarkable developments, we thought this would be an excellent opportunity to reflect on life, mind, and consciousness at ALIFE.

The term 'ghost in the machine' describes the mind (the 'ghost') as separate from the body (the 'machine'). It is in this dualist framework that a wide range of modern AI models is currently investigated. Among these, large language models, exemplified by ChatGPT, have seemingly managed to pass the Turing test. They now often engage in conversations with humans, generating sentences through predictions based only on knowledge acquired through text data. Thanks to their incredible achievements, they are often brought out in conversations regarding the nature of language, cognition and intelligence.

These topics are also close to the ALife community, and they have been discussed at length at different iterations of the ALIFE conferences. Within ALife, it is often argued that a body is likely necessary to ground the meanings of the symbols being exchanged. At the same time, as long as the goal is just to *appear* to converse like a human, it turned out that this could be achieved by simply training larger and larger models with copious amounts of data.

Our hope is to stimulate and foster a healthy discussion around 'ghosts' (or their lack of) and 'machines' that takes into account some of the more recent topics discussed, for instance, within the field of AI. From Sutton's "bitter lesson" highlighting how we seem to get better results in the long run by simply leveraging more computation and more data, to the life-likeness and seemingly intelligent processes of decision making displayed by current AI models.

Today, more than ever, we believe that the role of ALife is to guide us towards breakthroughs beyond these incredible but still, we believe, *empty* shells. To do so, we encourage the ALife community to continue to pursue its astounding research program, while at the same to embrace new technologies and ideas derived from adjacent fields, including but not limited to AI, so to serve as a catalyst for new discoveries that relate to, or explain away, the 'ghost in the machine'.

The ALife 2023 Program

We received a total of 243 full paper and abstract submissions. Our Program Committee reviewed all submissions in a double-blind process. Senior Program Committee members then performed a topic-wide meta-review to recommend acceptance/rejection decisions. As a result, 99 submissions were accepted for oral presentations and 43 for poster presentations, all of which are included in these proceedings.

The conference also hosted five special sessions to focus on specific topics that could expand the ALife landscape. In addition, eight workshops and nine tutorials were held. Two of our seven keynote speakers were invited to participate in an outreach (virtual) event open to the general public. The event discussed topics at the intersection between ALife and consciousness science. Finally, as part of ALIFE 2023, we introduced Neuromatch, an activity of scientific matchmaking

designed to create new opportunities for scientists who have similar approaches to their work or study similar problems to meet.

More specifically, the conference program of this year included the following:

- Seven keynote presentations by internationally renowned speakers:
  - Pamela Lyon (University of Adelaide, Australia)
  - Jun Tani (Okinawa Institute of Technology, Japan)
  - Anil Seth (University of Sussex, UK)
  - Malika Auvray (Institute of Intelligent Systems and Robotics (ISIR) - Sorbonne-University - CNRS, France)
  - David Wolpert (Santa Fe Institute and Arizona State University, USA)
  - Yuji Ikegaya (University of Tokyo, Japan)
  - Ted Chiang (Science fiction writer, USA)
- A dedicated poster session
- Five special sessions:
  - Agent-Based Modelling of Human Behaviour (ABMHuB'23), organized by Soo Ling Lim and Peter J. Bentley
  - Vita Ludens: Playfulness in Living Systems", organized by Olaf Witkowski and Yuko Ishihara
  - (In)human Values And Artificial Agency, organized by Simon McGregor, Rory Greig and Chris Buckley
  - ALife And Society VII, organized by Imran Khan and Peter Lewis
  - Artificial Life Journal Session, organized by Alan Dorin and Susan Stepney
- Eight workshops:
  - Cognitive feelings: Towards multi-disciplinary approaches for realizing artificial systems with cognitive capacities, organized by Jie Mei, Hiroki Kojima, Yuichi Yamashita, and Yukie Nagai
  - ALife for and from video games, organized by Andrea Fanti, Roberto Gallotta, and Lisa Soros
  - Molecular Communication Approaches for wetware Artificial Life, organized by Pasquale Stano, Michael Barros, Malcom Egan, Murat Kuscu, Yutetsu Kuruma, and Tadashi Nakano
  - CHEMALIFORMS III: The Third Workshop on Chemistry and Artificial Life Forms, organized by Jitka Čejková, Richard Löffler, and Tan Phat Huynh
  - Emerging Researchers in Artificial Life, organized by Federico Pigozzi, Abraham J. Leite, Imy Khan, Austin Ferguson, Fernando Rodriguez, and Richard Löffler
  - SB-AI 8. What can Synthetic Biology offer to Artificial Intelligence? Strategies and Perspectives for Embodied Chemical Approaches to AI, organized by Luisa Damiano, Pasquale Stano, and Yutetsu Kuruma
  - The Distributed Ghost: Cellular Automata, Distributed Dynamical Systems, and their applications to intelligence, organized by Stefano Nichele, Hiroki Sayama, Chrystopher Nehaniv, Eric Medvet, and Mario Pavone
  - Values in the machine: AI Alignment and ALife, organized by Simon McGregor, Rory Greig, and Chris Buckley
- Nine tutorials:
  - The OpenMOLE platform for model exploration and validation, organized by Juste Raimbault, Romain Reuillon, and Mathieu Leclaire
  - Phylogenies: how and why to track them in artificial life, organized by Emily Dolson, Matthew Andres Moreno, and Alexander Lalejini
  - Evolving Robot Bodies and Brains in Unity, organized by Frank Veenstra, Emma Stensby Norstein, and Kyrre Glette
  - Cellular Automata, Self-Reproduction & Complexity, organized by Chrystopher L. Nehaniv

  - How to build Research Software: Python, organized by Penn Faulkner Rainford
  - Untangling Cognition: How Information Theory can demystify brains, organized by Clifford Bohm
  - Self-Organizing Systems with Machine Learning, organized by Bert Chan and Alexander Mordvintsev
  - Writing research software well and collaboratively in Python: best practices around software sustainability, collaborative work, and open- and reproducible science, organized by Nadine Spychala
  - Dynamical Consciousness: Filling the explanatory gap, organized by Antoine Pasquali
- A special public event with Ted Chiang:
  - Public broadcast featuring Ted Chiang, in a dialogue with Anil Seth, chaired and moderated by Susan Stepney
- Neuromatch:
  - Connecting scientists to develop new collaborations and projects based on shared interests.

About the Editors

Hiroyuki Iizuka (General Chair)
Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN), Hokkaido University

Hiroyuki Iizuka is a Specially Appointed Associate Professor at the Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN) at Hokkaido University in Japan. He received his Ph.D. degree in Multidisciplinary Sciences from the University of Tokyo, Japan, in 2004. His primary research interests lie in artificial life, complex systems, and artificial intelligence, with a special focus on cognitive modeling using deep learning and the construction of hybrid systems combining machines and life.

Keisuke Suzuki (Vice Chair)
Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN), Hokkaido University

Keisuke Suzuki is a Specially Appointed Associate Professor at the Center for Human Nature, Artificial Intelligence, and Neuroscience (CHAIN) at Hokkaido University in Japan. He obtained his Ph.D. in Artificial Life from the University of Tokyo in 2007. He stayed as a research fellow in RIKEN Brain Science Institute, working on human cognitive functions in virtual reality environments (2008-2011). Here, with his colleagues, he developed a novel virtual reality system called Substitutional Reality. In this setup, people believe they are experiencing real-world scenes even though they are just exposed to pre-recorded ones. In 2011 he joined the Sackler Centre for Consciousness Science at the University of Sussex as a post-doctoral research fellow. Keisuke's research focuses on the study of consciousness in terms of embodied cognition, investigating ideas like body ownership, feeling of agency, sense of presence, etc. His approach builds on state-of-the-art virtual reality setups for the study of conscious presence and the bodily-self, complemented by theoretical modelling of embodied self-consciousness.

Ryoko Uno (Finance Chair)
Tokyo University of Agriculture and Technology, Division of Language and Culture Studies

Ryoko Uno is a professor at Tokyo University of Agriculture and Technology. She obtained her Ph.D. in linguistics from the University of Tokyo in 2006. Her specialties are cognitive linguistics and experimental semiotics. Her research is driven by a curiosity about whether the language we use is a vital part of who we are. She focuses on investigating how new words emerge in both natural and artificial languages, exploring the mechanisms behind them.

Luisa Damiano (Programme Chair)
Department of Communication, Arts and Media, IULM University

Luisa Damiano is professor of logic and philosophy of science at IULM University, Milan, Italy, where she directs the PhD School for Communication Studies and co-directs the research center CRiSiCo. Her main research areas are: Epistemology of Complex Systems; Epistemology of the Cognitive Sciences; Epistemology of the Sciences of the Artificial, with a specific interest in the (wetware, hardware and software) synthetic modeling of life and cognition.

Nadine Spychala (Workshop and Tutorial Chair)
Department of Informatics, University of Sussex and Software Sustainability Institute

Nadine is a doctoral researcher in computational/theoretical neuroscience and complex systems at the University of Sussex, Brighton, UK where she validates multi-scale information-theoretic measures of complexity and emergence in different system models (autoregressive networks, Kuramoto oscillators, variational inference). Her work can be described as a solid mixture of mathematics, neuroscience, machine learning, as well as philosophy. She cares about open and reproducible research (and, in this context, good research software) that is aligned with ethical research culture and incentives. She is a fellow at the Software Sustainability Institute.

Miguel Aguilera (Keynote Chair)
BCAM – Basque Center for Applied Mathematics and IKERBASQUE, Basque Foundation for Science

Miguel Aguilera is an Ikerbasque Research Fellow at the Basque Center for Applied Mathematics (BCAM) in Bilbao, Spain, working at the crossroads of complex systems, artificial life, and cognitive science. He combines methods from statistical mechanics, nonlinear systems, stochastic thermodynamics, and information theory to study emergence of adaptive behavior, autonomy, and agency at biological, psychological, and social levels.

Eduardo J. Izquierdo (Special Sessions and Awards Chair)
Cognitive Science Program, Indiana University Bloomington

Eduardo Izquierdo is an assistant professor for the Cognitive Science Program at Indiana University Bloomington. He is interested in understanding how behavior arises from the interaction between an organism's nervous system, its body, and its environment. Towards this end, he works on the evolution and analysis of dynamical models of nervous systems that, when embodied and situated, display the robustness, flexibility, and adaptivity of living organisms. He received his bachelor's degree from Universidad Simon Bolivar in 2002, and his Ph.D. from the University of Sussex in 2008. In 2015, he joined the faculty of the Cognitive Science Program at Indiana University Bloomington.

Reiji Suzuki (Sponsors and Local Chair)
Graduate School of Informatics, Nagoya University

Reiji Suzuki is an Associate Professor at the Department of Complex Systems Science, Graduate School of Informatics, Nagoya University in Nagoya, Japan. His research encompasses interactions between developmental (learning), ecological and evolutionary processes (eco-evo-devo) in biological and social systems utilizing artificial life approaches such as agent-based models and artificial creatures. He is also interested in understanding acoustic interactions among songbirds as complex systems and applying robot audition techniques to better observation of their spatial-spectral-temporal patterns in field conditions.

Manuel Baltieri (Proceedings Chair)
Araya Inc.

Manuel Baltieri is a Chief Researcher at Araya Inc. in Tokyo, Japan and a Honorary Senior Research Fellow at the University of Sussex, Brighton, UK. He received his Ph.D. in Computer Science and Artificial Intelligence from the University of Sussex in 2019. During his Ph.D. he was a visiting student at ELSI Origins of Life Network, Tokyo, Japan. He then joined RIKEN CBS (Centre for Brain Science) in Wako, Japan, as a Royal Society/JSPS Postdoctoral research fellow. In 2021 he moved to Araya Inc. as a full time researcher. His research focuses on the foundations of cognitive science and (artificial) intelligence, using methods from probabilistic inference, control theory and applied category theory. His research interests include agency and agent-centric perspectives on uncertainty, minimal cognition, action-perception loops and feedback control, enactive and embodied accounts of sensorimotor coupling, the origins of life and their connections to cognition.

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The organizing committee would like to thank all of the reviewers and meta-reviewers who contributed to the review process and without whom a successful conference would not have been possible. This year we had more submissions than we could have initially imagined, we thus thank all the reviewers that generously offered their help at different stages to ensure we could provide the best feedback we could have. We would like to thank all the authors and congratulate them for the incredible quality of their submissions.

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