



## 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 Sychala** (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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Manuel Baltieri





# Conference Program

i Preface

## Short Abstracts of Keynote Presentations

1

- 1 Who's afraid of ghosts? (Especially if the machine can't run without one)  
*Pamela Lyon*
- 1 Cognitive Neurorobotics Studies Utilizing the Free Energy Principle: Towards an Ontological Understanding of the Mind)  
*Jun Tani*
- 2 Being a beast machine: consciousness, life, and the prospects for conscious AI)  
*Anil Seth*
- 2 Hearing tactile interactions, visualizing sounds, touching distances: Current directions in sensory conversion research  
*Malika Auvray*
- 3 Stochastic thermodynamics of Boolean circuits, finite automata and Turing machines)  
*David Wolpert*
- 3 AI-assisted brain enhancement  
*Yuji Ikegaya*
- 3 Digent Education: Teaching Artificial Lifeforms)  
*Ted Chiang*

## General Conference

3

### Accepted oral presentations

3

- 4 Growing Steerable Neural Cellular Automata  
*Ettore Randazzo, Alexander Mordvintsev and Craig Fouts*
- 11 Hardware speculation for robotic plants through cellular automata principle  
*Marília Lyra Bergamo and Sandro Benigno*
- 14 Efficient Exploration using Model-Based Quality-Diversity with Gradients  
*Bryan Lim, Manon Flageat and Antoine Cully*
- 24 Neural Cellular Automata Can Respond to Signals  
*James Stovold*
- 33 Daphnia as a living sensor for underwater biohybrid systems  
*Wiktoria Rajewicz, Thomas Schmickl and Ronald Thenius*
- 36 Multi – vs. Single – Perceptron Approach for Modelling the Pattern Recognition and Classification in a Multi-Compartment Adaptive Immune System Model  
*Stephan Scheidegger, Udo S. Gaipl and Rudolf M. Fuchslin*
- 43 Can Artificial Visual Signals Extend Fish's Perception Fields?  
*Zhihua Song, Daoyuan Lin, Tingyu Chen, Yangyang Xu and Wen-chi Yang*
- 51 Artificial Neural Microcircuits for use in Neuromorphic System Design  
*Andrew Walter, Shimeng Wu, Andy Tyrrell, Liam McDaid, Malachy McElholm, Nidhin Thandassery Sumithran, Jim Harkin and Martin A. Trefzer*
- 59 A  $\pi$ -calculus Model of Supercoiling DNA Circuits  
*Penn Faulkner Rainford, Aalap Mogre, Victor Velasco-Berrelleza, Chares J Dorman, Sarah Harris, Carsten Kroeger and Susan Stepney*
- 68 Coevolution of Camouflage  
*Craig Reynolds*

- 79 Biologically Informed Generative Adversarial Networks for Modeling and Prediction  
*Anagha Savit*
- 82 The role of the environment in collective perception: A generic complexity measure  
*Dari Trendafilov, Ahmed Almansoori, Timoteo Carletti and Elio Tuci*
- 92 Self-Replication, Spontaneous Mutations, and Exponential Genetic Drift in Neural Cellular Automata  
*Lana Sinapayen*
- 100 Minimum Equivalence in Random Boolean Networks, Elementary Cellular Automata, and Beyond  
*Tom Eivind Glover, Ruben Jahren, Ola Huse Ramstad and Stefano Nichele*
- 109 Canonical Computations in Cellular Automata and Their Application for Reservoir Computing  
*Trym A. E. Lindell, Barbora Hudcová and Stefano Nichele*
- 118 Fitness Agnostic Adaptive Sampling Lexicase Selection  
*Jared M. Moore and Adam Stanton*
- 126 The Sun Always Rises: Behavioral Attunement to Abiotic Reins  
*Eden Forbes and Randall Beer*
- 135 What is a Stimulus? A Computational Perspective on an Associative Learning Model  
*Rui Cardoso, Niall Donnelly, Lucy Cheke, Edward Keedwell and Murray Shanahan*
- 138 Hierarchical Neural Cellular Automata  
*Ritu Pande and Daniele Grattarola*
- 147 Towards a Theory of Mind for Artificial Intelligence Agents  
*Jory Schossau and Arend Hintze*
- 157 Environmental variability and network structure determine the optimal plasticity mechanisms in embodied agents  
*Emmanouil Giannakakis, Sina Khajehabdollahi and Anna Levina*
- 167 The Degeneracy of Control Architectures in Cell Lineages: Implications for Tissue Homeostasis  
*Gabriel J. Severino, Zachary Laborde and Ann-Sophie Barwich*
- 176 Between you and me: A systematic analysis of mutual social interaction in perceptual crossing agents  
*Gabriel J. Severino, Haily Merritt and Eduardo J. Izquierdo*
- 185 Synthetic minimal cell with artificial metabolic pathways  
*Minoru Kurisu, Peter Walde and Masayuki Imai*
- 188 Spatial Embedding of Edges in a Synaptic Generative Model of *C. elegans*  
*Zachary Laborde and Eduardo J. Izquierdo*
- 197 Lenia in a petri dish: Interactions between organisms and their environment in a Lenia with growth based on resource consumption  
*Reiji Suzuki, Kenta Asakura and Takaya Arita*
- 200 Ghosts in a Shell: An Immersive Art Experience for ALIFE23  
*Alyssa Adams, Oneris Rico, Nicholas Guttenberg and Olaf Witkowski*
- 202 Evolving Vestibular Bipedal Locomotion with Spring-Mass Tetrahedra  
*Jeffrey Ventrella*
- 210 Between Individual Brains and Collective Behavior: Multi-level Emergence in a Group Formation Task  
*Ekaterina Sangati, Federico Sangati, Yi-Shan Cheng and Acer Yu-Chan Chang*
- 219 Domestication syndrome via indirect selection in simulated cereal grains  
*Christopher Marriott and Jobran Chebib*
- 228 The enactive account of motivated activity and the hard problem of efficacy (HPE): Artificial life meets the physics of life  
*Tom Froese and Georgii Karelin*
- 239 Inverse Bayesian Feedback Model of True Slime Mold  
*Iori Tani*

- 242 How Excessive Elitism Can Facilitate the Evolution of Morphology and Behavior of Artificial Creatures with NEAT  
*Siti Aisyah Binti Jaafar, Reiji Suzuki, Satoru Komori and Takaya Arita*
- 245 Individuality in Swarm Robots with the Case-study of Kilobots: Noise, Bug, or Feature?  
*Mohsen Raoufi, Pawel Romanczuk and Heiko Hamann*
- 255 Greedy Agents and Interfering Humans - An artwork making humans meddle with a life in the machine  
*Tatsuo Unemi, Daniel Bisig and Philippe Kocher*
- 258 Agent Heterogeneity Mediates Extremism in an Adaptive Social Network Model  
*Seth Bullock and Hiroki Sayama*
- 267 Life-like Behavior of an Oil Droplet in an Aqueous Surfactant Solution: Comparative Analysis with Tetrahymena Movement and Numerical Investigation  
*Riku Adachi, Hiroki Kojima and Takashi Ikegami*
- 270 Embodied Time Perception: Effects of Time Delay on Hand Motion and Time Perception in Virtual Environments  
*Atsushi Masumori and Takashi Ikegami*
- 273 Exploring the Emergent Behaviors of Particle Lenia: A Perturbation-Response Analysis for Computational Agency  
*Kazuya Horibe, Keisuke Suzuki, Takato Horii and Hiroshi Ishiguro*
- 282 aRtificial death: learning from stories of failure  
*Marcin Korecki, Cesare Carissimo and Tanner Lund*
- 292 Development of Concept Representation of Behavior through Mimicking and Imitation in a Humanoid Robot Alter3  
*Takahide Yoshida, Atsushi Masumori, Norihiro Maruyama, John Smith and Takashi Ikegami*
- 300 Implementation of Lenia as a Reaction-Diffusion system  
*Hiroki Kojima and Takashi Ikegami*
- 307 A Comparative Study of Brain Reproduction Methods for Morphologically Evolving Robots  
*Jie Luo, Carlo Longhi and Agoston E. Eiben*
- 316 Quantifying higher-order entropy production in organized nonequilibrium states  
*Miguel Aguilera and Artemy Kolchinsky*
- 319 Proprioceptive Drift Can Be Caused by Simple Sensory Prediction  
*Kohei Harada, Wataru Noguchi, Hiroyuki Iizuka and Masahito Yamamoto*
- 327 Emergent Naming System in an Unstructured Environment: a Shortest-Path Discovery Case Study  
*Nicolas Cambier, A.E. Eiben and Eliseo Ferrante*
- 336 Robustness of the Infomax Network for View Based Navigation of Long Routes  
*Amany Azevedo Amin, Efstathios Kagioulis, Alexander Dewar, Norbert Domcsek, Thomas Nowotny, Paul Graham and Andrew Philippides*
- 345 MODES Analysis of Prediction Games  
*Thomas Willkens and Jordan Pollack*
- 354 Evolving Dynamic Collective Behaviors by Minimizing Surprise  
*Tanja Katharina Kaiser, Christopher Kluth and Heiko Hamann*
- 357 Decomposing Viability Space  
*Connor McShaffrey and Randall Beer*
- 365 Exploring the relation of variational inference and integrated information in a minimal model  
*Nadine Spsychala and Miguel Aguilera*
- 368 A Simple Sparsity Function to Promote Evolutionary Search  
*Cliff Bohm, Arend Hintze and Jory Schossau*
- 377 Spatial community structure impedes language amalgamation in a population-based iterated learning model  
*George Sains, Conor Houghton and Seth Bullock*

- 386 Developmental Graph Cellular Automata  
*Riversdale Waldegrave, Susan Stepney and Martin Trefzer*
- 395 Optical Herding of Swarms: Toward Universal Control Algorithms for Microscopic Collectives  
*David Fielding, Imogen Taylor, Simon Jones, Sabine Hauert and Edmund Hunt*
- 404 Evolution of symbiotic task-based digital genomes: ectosymbiosis hastens the evolution of endosymbiosis  
*Kiara Johnson, Sylvie Dirkswager and Anya Vostinar*
- 407 In silico morphogenetic engineering with differentiable programming  
*Francesco Mottes, Ramya Deshpande, Alma Dal Co and Michael Brenner*
- 410 Locally adaptive cellular automata for goal-oriented self-organization  
*Sina Khajehabdollahi, Emmanouil Giannakakis, Victor Buendia, Georg Martius and Anna Levina*
- 420 A Markovian framework to study the evolution of complexity and resilience in chemical organizations  
*Tomas Veloz and Simon Hegele*
- 430 Exploring the Rich Behaviour of Developmental Graph Cellular Automata  
*Riversdale Waldegrave, Susan Stepney and Martin Trefzer*
- 439 Evolving Music from a Self-Organising Nanomagnetic Orchestra  
*Arthur Penty and Gunnar Tuft*
- 447 Dynamics of niche construction in adaptable populations evolving in diverse environments  
*Eleni Nisioti and Clément Moulin-Frier*
- 457 Go by Its Name: Evolution and Analysis of Conceptual Referential Communication  
*Siyu Yao, Joshua Nunley and Eduardo J Izquierdo*
- 466 Social Neural Network Soups with Surprise Minimization  
*Maximilian Zorn, Steffen Illium, Thomy Phan, Tanja Katharina Kaiser, Claudia Linnhoff-Popien and Thomas Gabor*
- 475 Toward cultures of rhythm in legged robots  
*Alex Szorkovszky, Frank Veenstra and Kyrre Glette*
- 478 Arbitrary Order Meta-Learning with Simple Population-Based Evolution  
*Chris Lu, Sebastian Towers and Jakob Foerster*
- 481 On the Existence of Information Bottlenecks in Living and Non-Living Systems  
*Michael Crosscombe and Hiroki Sato*
- 484 Does Kinematic-Based Pretraining Improve Evolution of Quadrupedal Gaits?  
*Kevin J. Ayala Ahumada Jared M. Moore and Anthony J. Clark*
- 487 Searching in the Dark: Evolving Biobot Swarm Compositions to Efficiently Explore Obstructed Environments  
*Piper Welch, Caitlin Grasso, Gizem Gumuskaya, Michael Levin and Josh Bongard*
- 496 Potentiating Mutations Facilitate the Evolution of Associative Learning in Digital Organisms  
*Austin Ferguson and Charles Ofria*
- 505 Open-Ended Library Learning in Unsupervised Program Synthesis  
*Claire Glanois, Shyam Sudhakaran, Elias Najarro and Sebastian Risi*
- 514 Interaction Strengths Affect Whether Ecological Networks Promote the Initiation of Egalitarian Major Transitions  
*Sydney Leither, Max Foreback, David A. Baum and Emily Dolson*
- 524 Multimodal Plastic Body and Peripersonal Space Representation Developed Through Learning of Visuo-Tactile-Proprioceptive Sensations  
*Wataru Noguchi, Hiroyuki Iizuka and Masahito Yamamoto*
- 533 Frame by frame? A contrasting research framework for time experience  
*Fernando Rodriguez, Phil Husbands, Anindya Gosh and Ben White*
- 542 Effects of compliant and structural parts in evolved modular robots  
*Emma Stensby Norstein, Frank Veenstra, Kai Olav Ellefsen, Tønnes Nygaard and Kyrre Glette*

- 550 Real-time Evolution of Multicellularity with Artificial Gene Regulation  
*Dylan Cope*
- 559 The Role of Abiotic Parameters in the Promotion of Egalitarian Major Evolutionary Transitions  
*Max Foreback, Sydney Leither, David A. Baum and Emily Dolson*
- 568 Toward Phylogenetic Inference of Evolutionary Dynamics at Scale  
*Matthew Moreno, Emily Dolson and Santiago Rodriguez Papa*
- 578 Towards Self-Assembling Artificial Neural Networks through Neural Developmental Programs  
*Elias Najarro, Shyam Sudhakaran and Sebastian Risi*
- 588 A Robust Programmable Replicator for an Indefinitely Scalable Machine  
*David H. Ackley*
- 597 EINCASM: Emergent Intelligence in Neural Cellular Automaton Slime Molds  
*Aidan Barbieux and Rodrigo Canaan*

### Accepted poster presentations

600

- 600 An Optimized Search Strategy may be Induced by the Stochastic Response to Previously Visited Locations  
*Tomoko Sakiyama*
- 604 Dispelling Ghosts: Observations on Life and Mind  
*Inman Harvey*
- 613 Competitive Exclusion in an Artificial Foraging Ecosystem  
*John C. Stevenson*
- 623 An Empirical Model of Goldfish Escaping Strategy  
*Ziyue Chu, Jinxin Yang and Wen-chi Yang*
- 631 Investigating Goldfish's Behaviour Under Different Visual Stimuli  
*Zhihua Song, Tingyu Chen, Yangyang Xu and Wen-chi Yang*
- 640 The Impact of Agent Density and Environmental Factors on Target Tracking Swarms  
*Hian Lee Kwa, Julien Philippot and Roland Bouffanais*
- 648 Binding affinity distributions drive adaptation in GRN evolution  
*Yashwanth Lagisetty, Satpreet Singh and Ankit Patel*
- 651 Collective Cargo Transport and Sorting with Molecular Swarms  
*Nathanael Aubert-Kato, Geoff Nitschke, Ibuki Kawamata and Akira Kakugo*
- 660 Experimental evolution of music styles using automatic composition models  
*Eita Nakamura, Hitomi Kaneko, Takayuki Itoh and Kunihiko Kaneko*
- 663 Characterizing the Role of Homeostatic Plasticity in Central Pattern Generators  
*Lindsay Stolting, Randall D. Beer and Eduardo J. Izquierdo*
- 672 A Computational Method to Support Chemical Product Design Based on Multi-objective Optimisation and Graph Transformers  
*Flavio Soares Correa da Silva, Geoff Nitschke and Bilal Aslan*
- 682 Evolving Folding Bodies and Brains in Origami Robots  
*Rhett Flanagan and Geoff Nitschke*
- 685 Evolution of Pleiotropy and Epistasis in a Gene Regulatory Network  
*Priyanka Mehra and Arend Hintze*
- 688 Bayesian ghosts in a machine?  
*Martin Biehl and Nathaniel Virgo*
- 691 Network simulation of depression as a complex system with treatment components  
*Takumi Omizu and Yoshihiko Kunisato*
- 694 Towards open-ended evolution based on CVT-MAP-Elites with dynamic switching between feature spaces  
*Koki Usui, Reiji Suzuki and Takaya Arita*

- 697 Reformalizing the notion of autonomy as closure through category theory as an arrow-first mathematics  
*Ryuzo Hirota, Hayato Saigo and Shigeru Taguchi*
- 707 Computational evolution of gene circuit topologies to meet design requirements  
*Lewis Grozinger and Ángel Goñi-Moreno*
- 715 Exploring Multi-Level Inter-Scale Information Flow in Large-Scale Boids Model  
*Atsushi Masumori and Takashi Ikegami*
- 718 Engineering Surrogate Models for Boid Systems  
*Jan von Pichowski and Sebastian von Mammen*
- 727 Recognition of Behavioural Intention in Repeated Games using Machine Learning  
*Alessandro Di Stefano, Chrisina Jayne, Claudio Angione and The Anh Han*
- 738 Emergent rewards in open-ended systems  
*Richard Bailey*
- 741 A Chemical Compiler for the Synthesis of Branched Oligomers on Standardized Chemical Reaction Structures  
*Mathias S. Weyland, Dandolo Flumini, Johannes J. Schneider, Alessia Faggian, Aitor Patiño Diaz and Rudolf M. Füchslin*
- 747 Exorcizing the “Ghost” in the Machine: A Wetware Route to Explore Embodied Cognition  
*Luisa Damiano and Pasquale Stano*
- 750 Identifying molecular selection using Assembly Theory and closed-loop experiments  
*Amit Kahana, Michael Jirasek, Silke Asche, Abhishek Sharma, Stuart Marshall and Leroy Cronin*
- 753 Decentralized Control and Morphological Evolution of 2D Virtual Creatures  
*Frank Veenstra, Alex Szorkovszky and Kyrre Glette*
- 763 The Role of Disequilibrium in Evolutionary Discovery  
*Vincent Ragusa and Clifford Bohm*
- 766 Finding Sparse Initialisations using Neuroevolutionary Ticket Search (NeTS)  
*Alex Jackson, Nandi Schoots, Amin Ahantab, Michael Luck and Elizabeth Black*
- 776 The Nexican Stand-Off: Social Contracts and Popular Legitimacy in n-Player High Stakes Resource Competition Games  
*Matthew Scott and Jeremy Pitt*
- 785 Evolving Collective AI: Simulation of Ants Communicating via Chemicals  
*Ryosuke Takata, Yujin Tang, Yingtao Tian, Norihiro Maruyama, Hiroki Kojima and Takashi Ikegami*
- 788 Modeling Evolutionary Development with Indirect Encodings on Dynamic NK Fitness Landscapes  
*Jacob Ashworth, Julian Fiorito and Jason Yoder*
- 797 An Ising-like model for language evolution  
*Conor Houghton*
- 800 Evolutionary Algorithms in the Light of SGD: Limit Equivalence, Minima Flatness and Transfer Learning  
*Andrei Kucharavy, Rachid Guerraoui and Ljiljana Dolamic*
- 811 Emergence of Differentiation of Deterministic/Stochastic Behavior in Ants’ Collectives  
*Norihiro Maruyama, Michael Crosscombe, Shigeto Dobata and Takashi Ikegami*
- 814 Design and preliminary results of a joint metamemory experiment for the evolution of co-representation  
*Yusuke Yamato, Reiji Suzuki and Takaya Arita*

## Special Session: Agent-Based Modelling of Human Behaviour (ABMHuB’23)

817

### Accepted oral presentations

817

- 817 Optimisation of hybrid institutional incentives for cooperation in finite populations  
*Manh Hong Duong, Calina M. Durbac and The Anh Han*

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|--|---|------------|
| 820  | How Individual Heterogeneity impacts Spreading Dynamics in Urban Proximity Networks: A case-study of virus spreading in the city of Brussels<br><i>Yara Khaluf and Arne Vandenberghe</i>  |            |
| 828  | To Comply or Not: A Social Dynamics Analysis of Institutional Reward and Punishment for Commitment Compliance<br><i>The Anh Han</i>   |            |
| 832  | Examining the Role of Incentives in Scholarly Publishing with Multi-Agent Reinforcement Learning<br><i>Giulia Bernardi, Eric Medvet, Alberto Bartoli and Andrea De Lorenzo</i>  |            |
| 841  | A tale of two Regulatory Markets: the role of institutional incentives in supporting sustainable Regulatory Markets for future AI systems<br><i>Paolo Bova, Alessandro Di Stefano and The Anh Han</i>   |            |
| 844  | Simulating Disease Spread During Disaster Scenarios<br><i>Shiyu Jiang, Hee Joong Kim, Fabio Tanaka, Claus Aranha, Anna Bogdanova, Kimia Ghobadi and Anton Dahbura</i>   |            |
| 853  | Simulating the Evolutionary Response of a Viral Pandemic to Behaviour Change<br><i>Martin Hinsch, Eric Silverman and David Robertson</i>  |            |
| <b>Accepted poster presentations</b>                               |   | <b>856</b> |
| 856  | The Effect of Noise on the Emergence of Continuous Norms and its Evolutionary Dynamics<br><i>Stavros Anagnostou, Daniel Polani and Christoph Salge</i>  |            |
| 865  | Multi-agent City Expansion With Land Use and Transport<br><i>Luiz Fernando Silva Eugênio dos Santos, Claus Aranha and André Carlos Ponce de Leon Ferreira de Carvalho</i>   |            |
| 872  | The Clash of Agents' Worlds: Simulation Experiments for Investigating the Case of Encounters Between Agents With Different Social Ontogenies<br><i>Georgina Montserrat Reséndiz-Benhumea, Jesús M. Siqueiros-García, Carlos Gershenson, Gabriel Ramos Fernández and Katya Rodríguez-Vazquez</i> |            |
| <b>Special session: Vita Ludens: Playfulness in Living Systems</b> |   | <b>882</b> |
| <b>Accepted oral presentations</b>                                 |   | <b>882</b> |
| 882  | Free Lunch in Evolutionary Embodied Computation in Modular Robotics<br><i>Heiko Hamann and Thomas Schmickl</i>  |            |
| 885  | Designing Emergence in Games<br><i>Nicholas Guttenberg and L. B. Soros</i>  |            |
| 888  | Ecosystem of clusters formed by self-propelled droplet surfers<br><i>Richard J.G. Loeffler, Shinpei Tanaka, Silvia Holler and Martin M. Hanczyc</i>   |            |
| 891  | Flow-Lenia: Towards open-ended evolution in cellular automata through mass conservation and parameter localization<br><i>Erwan Plantec, Gautier Hamon, Mayalen Etcheverry, Pierre-Yves Oudeyer, Clément Moulin-Frier and Bert Wang-Chak Chan</i>  |            |
| <b>Accepted poster presentations</b>                               |   | <b>900</b> |
| 900  | Playing and Being Played by the Drums<br><i>Matthew Egbert</i>  |            |
| <b>Special session: (In)human Values And Artificial Agency</b>     |   | <b>903</b> |
| <b>Accepted oral presentations</b>                                 |   | <b>903</b> |



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|---|--|------------|
| 903   | Is ChatGPT Really Disembodied?<br><i>Simon McGregor</i>  |            |
| 912   | From Basic Empathy to Basic Trust in Human-Robot Relation: A Phenomenological Proposal<br><i>Abootaleb Safdari</i>   |            |
| 922   | Detecting and Classifying Degradation in Robotic Swarms: An Experimental Study<br><i>Seth Bullock, Jan Noyes, Victoria Steane, Chris Bennett, Wenwen Gao, Sophie Hart, Elliott Hogg and Debora Zanatto</i> |            |
| 925   | Free will and algorithms: a typical androrphism<br><i>Cristiano Cali</i>   |            |
| <b>Accepted poster presentations</b>                    |  | <b>930</b> |
| 930   | Timescales, Levels of Organization, and Multi-objective Agents<br><i>Charles Wan</i>   |            |
| 933   | A Naturalised Account of Planning Across Intelligent Systems<br><i>Nora Ammann and Clem von Stengel</i>  |            |
| <b>Special Session: ALife And Society VII</b>           |  | <b>936</b> |
| <b>Accepted oral presentations</b>                      |  | <b>936</b> |
| 936   | Social Emotional Valence for Regulating Empathy in Active Inference<br><i>Tadayuki Matsumura, Kanako Esaki, Shunsuke Minusa, Yang Shao, Chihiro Yoshimura and Hiroyuki Mizuno</i>                          |            |
| 939   | Exploring Intervention in Co-Evolving Deliberative Neuro-Evolution with Reflective Governance for the Sustainable Foraging Problem<br><i>Aishwaryaprajna and Peter Lewis</i>                               |            |
| 948   | Of typewriters and PCs<br><i>Federico Pigozzi</i>  |            |
| <b>Accepted poster presentations</b>                    |  | <b>956</b> |
| 956   | The Cognitive Archaeology of Sociocultural Lifeforms<br><i>Avel Guénin-Carlut, Ben White and Lorena Sganzerla</i>  |            |
| 965   | Innovation dynamics in multi-scalar systems of cities<br><i>Juste Raimbault and Denise Pumain</i>  |            |
| <b>Special Session: Artificial Life Journal Session</b> |  | <b>974</b> |
| 974   | Emergence in artificial life<br><i>Carlos Gershenson</i>   |            |
| 974   | Digihive: Artificial chemistry environment for modeling of self-organization phenomena<br><i>Rafał Sienkiewicz and Wojciech Jędruch</i>  |            |
| 974   | How lévy flights triggered by the presence of defectors affect evolution of cooperation in spatial games<br><i>Genki Ichinose, Daiki Miyagawa, Erika Chiba, and Hiroki Sayama</i>                          |            |
| 974   | Interdependent self-organizing mechanisms for cooperative survival<br><i>Matthew Scott and Jeremy Pitt</i>   |            |
| 974   | An ansatz for computational undecidability in RNA automata<br><i>Adam J. Svahn and Mikhail Prokopenko</i>  |            |
| 974   | Morphological development at the evolutionary timescale: Robotic developmental evolution<br><i>Fabien CY Benureau and Jun Tani</i>   |            |

- 974 Computation by convective logic gates and thermal communication  
*Stuart Bartlett, Andrew K Gao, and Yuk L Yung*
- 974 Monte carlo physarum machine: Characteristics of pattern formation in continuous stochastic transport networks  
*Oskar Elek, Joseph N Burchett, J Xavier Prochaska, and Angus G Forbes*
- 974 From dynamics to novelty: An agent-based model of the economic system  
*Gustavo Recio, Wolfgang Banzhaf, and Roger White*