

Editorial Introduction to the 2021 Conference on Artificial Life Special Issue

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This special issue of *Artificial Life* journal presents some of the best papers of the Conference on Artificial Life ALIFE 2021, which was originally scheduled to be held in Prague, Czech Republic, on July 19–23. However, because of the COVID-19 pandemic and its repercussions, the ALIFE 2021 conference took place solely online (Figure 1). Nevertheless, it was a wonderful event with around 400 participants and a busy program that offered 9 keynote talks, 27 hours of 6 special sessions, almost 40 hours of 11 workshops, 5 tutorials, and 64 talks in parallel sessions. The organizing committee worked intensively to create a virtual conference that gave as much of a real conference atmosphere as possible, so there were also a virtual art gallery, virtual pubs, and virtual coffee rooms. The social program offered the documentary movie *Solutions* and a THEaiTRE project *Can a Robot Write a Theatre Play?* The program also included a dedicated session 1971–2021: Fifty Years with Autopoiesis, in memory of Francisco Varela and Humberto Maturana, who passed away that year.

The theme of ALIFE 2021 was *Robots: The century past and the century ahead*, on the occasion of the centenary of Karel Čapek's *R.U.R.* (subtitled as *Rossum's Universal Robots*; Čapek, 1920) and the worldwide-used word *robot*, which comes from this play, which premiered in Prague in 1921 (Čejková, 2021). In honor of this famous literary work, we had a student essay competition where undergraduate and PhD students submitted essays related to *R.U.R.*, robots, artificial life, and/or artificial intelligence. Another literary piece of work that paid tribute to *R.U.R.* was the book *Robot 100* (Čejková, 2020). The Czech edition was released in November 2020 by the University of Chemistry and Technology Prague (which hosted the ALIFE 2021 conference) and included contemporary perspectives on Čapek's one-hundred-year old piece through the eyes of one hundred personalities from the Czech Republic and from around the world, including scientists, writers, journalists,



Figure 1. Original logo of the ALIFE 2021 conference in Prague and its modified version for the virtual conference. (Graphic design: Tereza Tomáštková).

artists, and athletes. More than half of the authors were artificial life researchers, who contributed to the book with brilliant chapters about the history and progress of fields such as robotics, synthetic biology, artificial intelligence, and, of course, artificial life, and which also discussed the challenges arising from today's modern technologies. The English edition will be published by MIT Press in 2023 and as its title *Karel Čapek's R.U.R. and the Vision of Artificial Life* suggests, it will focus on artificial life.

The ALIFE 2021 conference attracted a total of 158 submissions, and all of them were reviewed typically by three reviewers. Senior program committee members then performed a topic-wide meta-review to derive acceptance decisions. As a result, 58 full papers and 50 extended abstracts were accepted for publication in the open-access conference proceedings available from the MIT Press website (Čejková et al., 2021). The authors of the best papers (based on their peer review scores and the quality of their presentations) were invited to submit an extended version of their conference manuscript, which went through another round of peer review and revision, for journal publication. As a result, there are six papers included in this special issue.

- This special issue starts with an innovative paper on crowd simulations. Amos and Webster (2022) used a Turing test to identify realistic features of real crowds that are generally omitted from simulation models. Starting from their previous results they found out that participants have a better performance if previously trained.
- Bohm et al. (2022) used agent-based AI to understand which components and techniques are required for the development of an engineering toolkit to construct artificial cognitive systems. They propose a technique called *the comparative hybrid approach* and developed a proof-of-concept by systematically analyzing components from three evolvable substrates: recurrent artificial neural networks, Markov brains, and Cartesian genetic programming.

Their results demonstrate that the comparative hybrid approach can identify structural subcomponents that predict task performance across multiple computational substrates.

- Grohens et al. (2022) studied DNA supercoiling and transcription at the genome scale, and created a model of gene expression based on the supercoiling-transcription coupling. By understanding the differentiated responses in gene expression levels to changes in the environment, they use an evolutionary perspective to demonstrate that the nonlinear response could serve the evolution of specialized phenotypes.
- Khajehabdollahi et al. (2022) extend and revise a previous study on systems operating close to the critical state, by simulating evolving foraging agents controlled by neural networks that can adapt the agents' dynamical regime throughout evolution. The populations discovering solutions surprisingly evolved to be subcritical. Their work suggests that although optimality can be obtained in a subcritical regime, initializing near criticality is crucial for efficiency at finding optimal solutions for new tasks of unknown complexity.
- Stanton and Moore (2022) use an evolutionary robotics approach to investigate the ability of Lexicase selection to generalize across multiple tasks, with each task again broken down into many instances. Their results indicate that Lexicase is a viable mechanism for multi-tasking, to a certain degree of interference between tasks, and support the notion that a naive, uniform random sampling strategy turns out to be best overall in terms of final task performance, simplicity of implementation, and computational efficiency.
- Whitley et al. (2022) explore evolvable hardware as an application of evolutionary algorithms to hardware systems during design and/or operation, concentrating on unlocked field programmable gate arrays (FPGAs) evolved through genetic manipulation of their binary circuit. They demonstrate the intrinsic evolution of two non-trivial analog circuits with interesting properties in terms of amplitude maximization, pulse oscillation, and robustness to temperature variation and across-chip circuit translation.

Acknowledgments

I (Jitka Čejková) am very happy to write this acknowledgment note on behalf of the Organizing Committee of ALIFE 2021. I would like to start by calling special attention to co-organizers and co-editors of the conference proceedings and this special issue: Silvia Holler, Lisa Soros, Richard Löffler, and Olaf Witkowski. Further I would like to thank all conference co-organizers and the organizers of workshops, special sessions, and tutorials, and all members of the art jury and the student essay competition jury. I wish to thank all of the reviewers and meta-reviewers who contributed to the review process of both the conference proceedings and this special issue and without whom a successful conference would not have been possible. Of course, we thank all authors who submitted their papers and extended abstracts to this conference. We are also grateful for the generous support of the International Society for Artificial Life (ISAL, <https://alife.org>) and the University of Chemistry and Technology in Prague (www.vscht.cz). Finally, we would like to give special thanks to Susan Stepney and Alan Dorin, the Editors-in-Chief of the *Artificial Life* journal, and Linda Reedijk, the Editorial Assistant, for their help, encouragement, and support in this special issue.

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