Marko Cvjetko

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I am a 2nd year PhD student supervised by Pierre-Yves Oudeyer and Clément Moulin-Frier, developing curiosity-driven AI for scientific discovery. I draw on goal-conditioned reinforcement learning, intrinsically motivated exploration, vision–language models, and evolutionary search to build agents that autonomously explore, characterize, and control complex systems. I apply these methods to artificial life substrates — such as cellular automata — to study open-ended evolution and self-organizing phenomena. I am extending this program toward deeper integration of LLMs as discovery partners in the experimental loop, and toward more biologically grounded substrates through an ongoing collaboration with the Levin Lab. I am a 2026 DISI fellow and will visit Clément Hongler's group at EPFL in May 2026.

PUBLICATIONS

Under review

The Artificial Experimentalist: Discovery and Control of Self-Organizing Phenomena with Autotelic Reinforcement Learning. M. Cvjetko, B. Hartl, M. Levin, C. Moulin-Frier, P.-Y. Oudeyer. Submitted to *ALIFE 2026*. [project page]. *Goal-conditioned RL agent that discovers and controls self-organizing patterns in cellular automata via minimal local interventions, with zero-shot generalization to unseen dynamics and action spaces.*

Journal (invited, in preparation)

Extension of *Exploring Flow-Lenia Universes with a Curiosity-driven AI Scientist* (ALIFE 2025) for the *Artificial Life* journal special issue.

Conference papers

Exploring Flow-Lenia Universes with a Curiosity-driven AI Scientist: Discovering Diverse Ecosystem Dynamics. T. Michel, M. Cvjetko **(co-first authors)**, G. Hamon, P.-Y. Oudeyer, C. Moulin-Frier. In *Proc. ALIFE 2025*, pp. 633–643. doi:10.1162/ISAL.a.896. [project page]. *Population-based diversity search (IMGEPs) over system-wide complexity and evolutionary-activity metrics, surfacing ecosystem-level dynamics in Flow-Lenia.*

Expedition & Expansion: Leveraging Semantic Representations for Goal-Directed Exploration in Continuous Cellular Automata. S. Khajehabdollahi, G. Hamon, M. Cvjetko, P.-Y. Oudeyer, C. Moulin-Frier, C. Colas. In *Proc. ALIFE 2025*. doi:10.1162/ISAL.a.901. [project page]. *Hybrid exploration alternating novelty search with VLM-generated linguistic goals, providing evidence that VLM-generated goals act as stepping stones into unexplored regions of the behavioral space.*

Workshop paper

Evolving Symbiosis, from Barricelli's Legacy to Collective Intelligence: a Simulated and Conceptual Approach. J. Ashford, M. Cvjetko, R. Löffler, B. Sakallioglu, A. Valerio, M. Tataryn, B. Hartl, L. Pio-Lopez, S. Nichele. Accepted to *GECCO 2026 Workshop Proceedings*. arXiv:2603.08463. Runner-up award at ALICE 2026 Workshop, Copenhagen. *Revisits Barricelli's symbiogenesis simulations as a substrate for studying the emergence of cooperation and collective intelligence.*

Late-breaking abstract

Discovering and Controlling Diverse Self-Organised Patterns in Cellular Automata Using Autotelic Reinforcement Learning. M. Cvjetko, G. Hamon, C. Moulin-Frier, P.-Y. Oudeyer. *ALIFE 2025*, Kyoto, Japan. [HAL]. [project page]

HONORS, FELLOWSHIPS & RESEARCH VISITS

Diverse Intelligences Summer Institute (DISI) Fellow, Geneva, New York June 2026

- Selected for a 3-week transdisciplinary residency on the origins, nature, and future of intelligences (cognitive science, AI, biology, philosophy); cohort of ∼40 fellows funded by the John Templeton Foundation.

Funded research visit, Clément Hongler's group (EPFL) May 2026

- Two-week visit funded by the host group, coinciding with the Demeco 2026 workshop.

ALICE Workshop Runner-up Award, Copenhagen Feb 2026

- Awarded for "Evolving Symbiosis, from Barricelli's Legacy to Collective Intelligence".

EDUCATION

University of Bordeaux, Inria, Flowers Team, France

PhD thesis – Studying the emergence of open-ended evolution in cellular automata using curiosity-driven AI — Oct 2024 – current

- **Supervised by Pierre-Yves Oudeyer and Clément Moulin-Frier**
- Designing AI tools for assisted scientific discovery: agents that autonomously discover, characterize, and steer self-organizing phenomena, applied to Artificial Life substrates such as Lenia and the study of open-ended evolution.
- **Supervision**: co-supervising a Master's intern on the emergence of memory and learning in cellular automata, and two BSc students on a project investigating Turing-completeness in Lenia.
- **Service**: reviewer for *ALIFE 2026*.
- **Collaborations**: ongoing collaboration with Levin Lab (Tufts University) on autotelic agents for the discovery and control of self-organizing patterns; upcoming 2-week funded research visit hosted by Clément Hongler (EPFL), coinciding with the Demeco 2026 workshop (May 2026).

University of Zagreb, Faculty of Electrical Engineering and Computing (FER), Croatia

MSc, Computer Science — Sep 2021 – Jul 2024

- **MSc thesis**: Recognition of the respiratory signal from thermal video.

  Supervised by Prof. Sebastian Haesler and Prof. Siniša Šegvić

  In collaboration with Neuro-Electronics Research Flanders (imec/KU Leuven/VIB), project described in *work experience* section.
- **Selected courses**: *Machine Learning*, *Deep Learning*, *Soft Computing*, *Parallel Programming*

Erasmus student exchange at KU Leuven, Flanders, Belgium — Sep 2022 – Jul 2023

- Coursework from the Advanced Master AI programme
- **Selected courses**: *Cognitive Science*, *Philosophy of Mind*, *Linguistics and AI*, *Uncertainty in AI*, *Neural Computing*,

BSc, Computing — Sep 2016 – Sep 2021

- **BSc thesis**: *Music Synthesis using Artificial Intelligence* – LSTM next-note prediction on symbolically represented music. Supervised by Prof. Domagoj Jakobović.

WORK EXPERIENCE

Graduate Researcher, Neuro-Electronics Research Flanders (imec/KU Leuven/VIB), Haesler Lab (GitHub) — Mar 2023 – Jul 2024

- **Supervised by Prof. Sebastian Haesler**
- Developed a machine learning framework for extracting and analyzing respiratory responses of head-restrained mice from thermal video, in collaboration with experimental neuroscientists at Haesler Lab.
- Tackled low-data and domain-shift challenges via unsupervised and self-supervised learning with vision transformers and deep CNNs.
- Configured the data annotation platform, oversaw annotation tasks and trained students on annotation guidelines. Presented in a poster session at the institute's yearly retreat.

Machine Learning Engineer Internship, DoXray — Jun 2022 – Sep 2022

- Fine-tuned LayoutXLM — a multilingual multimodal (text + layout + vision) transformer — for named-entity recognition on German invoice documents, benchmarked against a BERT baseline. Blogpost.

PROJECTS

Generative models for unsupervised behavioral spaces in open-ended discovery (GitHub) 2026 – current

- Training diffusion models and variational autoencoders to represent complex system behavior and sample their parameters for open-ended diversity search
- Goal: replace hand-designed semantic descriptors with learned, generative behavior spaces that enable scalable goal-directed search and quality–diversity over continuous cellular automata.

Music-reactive cellular automata Nov 2024

- Real-time music-driven Lenia animations: tempo and frequency features drive a continuous cellular automaton (example). Built during the hack1robo hackathon.

Cellular Automata Study in JAX (GitHub) Jan – Mar 2024

- Lenia implementation in JAX; trained a 13-parameter neural network to learn Conway's Game of Life update rule.

Automatic Universal Taxonomies for Multi-Domain Semantic Segmentation (GitHub) 2023 – 2024

- Joint label space for semantic segmentation datasets via cross-dataset confusion matrices, enabling training of a single classification head on the union.

Can Augmentation Make Better Doctors? Data Augmentation in a Low-Resource Sequence Labeling Task 2022

Benchmarked data augmentations for BERT-based sequence labeling on a low-resource medical named entity recognition dataset.

SKILLS

Programming	Python (PyTorch, JAX, NumPy, Hugging Face Transformers, Stable-Baselines3, CleanRL, QDax, Optuna), C, Bash
HPC	Slurm, Singularity (parallel multi-node, multi-GPU workers, asynchronous coordination)
Tooling	Linux, Docker, Git, LaTeX, vLLM
Languages	Croatian (native), English (fluent), French (intermediate), German (beginner)