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Title: Biology-Inspired and Philosophy-Guided Modelling of Complex Systems

Abstract: Understanding complex systems such as living organisms is challenging because traditional analytical approaches for studying them are not well suited to model environments that change over time. Algorithmic approaches such as cellular automata and agent-based models have been proposed allowing to specify local rules that determine the dynamics of the system's entities and where the global system's dynamics emerges from dynamically interacting entities. It is straightforward to implement rules that update the environment simultaneously with the update of entities thus providing a more natural way to model complex systems in general. Even more so, it allows to study a system's behaviour based on the behaviour of entities, e.g., simple rules of a biological cell can be implemented and the emerging behaviour forming a tissue or tumour can be investigated. More generally speaking, this is a way to implement biology-inspired rules that can be experimentally measured and based on them the emergent complex behaviour of the system studied. However, we still lack understanding and tools for exploring what is happening between local rules and the resulting emergent behaviour. In the present talk, I present a computational framework to describe, model, implement, and interpret complex systems attempting to close the gap between rules and emergent behaviour. The framework is based on philosophy, particularly Gilbert Simondon's philosophy of individuation implementing the concepts of structure and operation, and Alfred N. Whitehead's philosophy of organism implementing the concepts of entity, adaptation, and control. The idea is to guide the modelling and implementation of biology-inspired models as well as follow their simulation by relating them to philosophical concepts.
Here, I use the computational framework for philosophy-guided modelling and implementation of gene regulation inspired self-modifying code exemplifying the proposed approach.

Biography: Patrik Christen is a lecturer of mathematics and programming at the Institute for Information Systems at FHNW. Prior to his current position, he held senior assistant and senior research associate positions at the Institute for Biomechanics at ETH Zurich and the Oxford Flight Group at the University of Oxford, respectively. He co-authored 90 conference contributions and 27 journal articles. He works on the modelling and simulation of complex systems with applications to open-ended evolutionary systems, self-modifying code, and explainable AI. His approach is inspired by biology, particularly evolution and gene regulation, and guided by philosophy, particularly Gilbert Simondon's philosophy of individuation and Alfred N. Whitehead's philosophy of organism. He is developing a computational framework to describe, model, implement, and interpret complex systems, and already showed that it allows implementing and exploring computational models such as cellular automata and artificial neural networks as well as deep concepts such as adaptation and control. The framework is currently used to explore and simulate open-ended evolution and self-modifying code, to implement a neurally-inspired data structure, and to better understand the inner workings of artificial neural networks.