CoCo Seminar Series Spring 2019

Hash Chemistry: An Open-Ended Evolutionary System with Cardinality Leap and Universal Fitness Evaluation

Dr. Hiroki Sayama
Professor of Systems Science and Industrial Engineering, Binghamton University

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Engineering Building H-9 (Knoll-MacDonald Commons / Watson Commons)

Open-ended evolution requires unbounded possibilities that evolving entities can explore. The cardinality of a set of those possibilities thus has a significant implication for the open-endedness of evolution. We propose that facilitating formation of higher-order entities is a generalizable, effective way to cause a "cardinality leap" in the set of possibilities that promotes open-endedness. We demonstrate this idea with a simple, proof-of-concept toy model called "Hash Chemistry" that uses a hash function as a universal fitness evaluator of evolving entities of any size/order. Simulation results showed that the cumulative number of unique replicating entities that appeared in evolution increased almost linearly along time without an apparent bound, demonstrating the effectiveness of the proposed cardinality leap. It was also observed that the number of individual entities involved in a single replication event gradually increased over time, indicating evolutionary appearance of higher-order entities. Moreover, these behaviors were not observed in control experiments in which fitness evaluators were replaced by random number generators. This strongly suggests that the dynamics observed in Hash Chemistry were indeed evolutionary behaviors driven by selection and adaptation taking place at multiple scales.

Dr. Hiroki Sayama is a Professor in the Department of Systems Science and Industrial Engineering and Director of the Center for Collective Dynamics of Complex Systems at Binghamton University. His research interests include complex dynamical networks, artificial life/chemistry, human social dynamics, interactive systems, and complex systems education. http://coco.binghamton.edu/