Thesis Defense

Computer Science Master's Program

"Coralai: Emergent Ecosystems of Neural Cellular Automata"

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Abstract:

Artificial intelligence has traditionally been approached through centralized architectures and optimization of specific metrics on large datasets. However, the frontiers of fields spanning cognitive science, biology, physics, and computer science suggest that intelligence is better understood as a multi-scale, decentralized, emergent phenomenon. As such, scaling up approaches that mirror the natural world may be one of the next big advances in AI. This thesis presents Coralai, a framework for efficiently simulating the emergence of diverse artificial life ecosystems integrated with modular physics. The key innovations of Coralai include: 1) Hosting diverse Neural Cellular Automata organisms in the same simulation that can interact and evolve; 2) Allowing user-defined physics and weather that organisms adapt to and can utilize to enact environmental changes; 3) Hardware-acceleration using Taichi, PyTorch, and HyperNEAT, enabling interactive evolution of ecosystems with 500k evolved parameters on a grid of 1m+ 16-channel physics-governed cells, all in real-time on a laptop. Initial experiments with Coralai demonstrate the emergence of diverse ecosystems of organisms that employ a variety of strategies to compete for resources in dynamic environments. Key observations include competing mobile and sessile organisms, organisms that exploit environmental niches like dense energy sources, and cyclic dynamics of greedy dominance out-competed by resilience.

Date: Friday, March 15, 2024
Time: 10:00 am – 12:00 pm
Zoom: https://calpoly.zoom.us/my/rcanaan
Committee: Dr. Canaan, Dr. Kurfess, Dr. Wood