CoCo Seminar Series Spring 2024

Stability, Integration, and Higher-Order Interactions in Complex Systems

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Hybrid (EB-T1 & Zoom; meeting link available on http://coco.binghamton.edu/)

In the last decade, there has been an explosion of interest in "higher-order" interactions in complex systems: interactions between groups of three or more elements that cannot be reduced to a bivariate network model. While there has been great progress in the development of novel tools for recognizing these beyond-pairwise structures, there has been comparatively less work on understanding what they "mean" for the dynamics of a given system. What, exactly, have we learned upon observing that the synergistic information is higher in system A versus system B? This talk will explore how evolutionary optimization can construct systems with prescribed patterns of higher-order redundancies and synergies, which can then by analyzed with standard tools from dynamical systems theory. This approach, using small boolean networks, reveals a trade-off between stability (highly redundant systems), and information-integration capacity (highly synergistic systems). Those systems that are stable cannot integrate information, and those systems that integrate information are generally unstable. Intriguingly, a measure of complexity original developed in the context of theoretical neuroscience, appears to partially balance this trade-off, suggesting a link between higher order redundancies, synergies, integration, and segregation.

Thomas Varley is a Postdoctoral Scientist at the University of Vermont, currently working on complex-systems and information-theoretic approaches to self-organization in soft robotics and synthetic biology. He obtained his MPhil in Clinical Neurosciences from the University of Cambridge, UK, and his dual PhD in Complex Systems & Network Science and Computational & Cognitive Neuroscience from Indiana University. His research interests include information theory, complex systems, brains, synergy and emergence.