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Variational Approaches to Quantify Self-organization in Complex Systems ATANU CHATTERJEE, WPI, GEORGI GEORGIEV, WPI, Assumption College, Tufts U., GERMANO IANNACCHIONE, WPI — Complex systems are thermodynamically open, far from equilibrium and are composed of a large number of interacting elements. The local interactions in these systems are initially uncorrelated however, due to the self-organizing, order appears spontaneously accompanied by a reduction in the local entropy. Here, we propose a first-principles variational approach to quantify the appearance of order in a complex system due to self-organization. For complex systems modeled as flow networks, a new metric is introduced, the action efficiency, which is the ratio of a u nit action for an element to cross between two adjacent nodes to the total action of the system. Due to the fundamental and universal nature of this metric, it serves as the basis to study self-organization and quantify order for our system of interest, the evolution of CPUs. We also incorporate other metrics like, system size, flows and computations in the system, and observe the inter-dependencies between them due to the presence of feedback loops between them. In part, our results also provide insights about the underlying physical essence of the Moore's law and the multiple logistic growth observed in technological progress.

Germano Iannacchione
WPI

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