Complexity of Life Conference

Bridging complexity scales and biological systems

Public Lecture

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Strong Emergence Arising from Weak Emergence

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Predictions of emergent phenomena, appearing on the macroscopic layer of a complex system, can fail if they are made by a microscopic model. This study demonstrates and analyses this claim on a well-known complex system, Conway's Game of Life. Straightforward macroscopic mean-field models are easily capable of predicting such emergent properties after they have been fitted to simulation data in an after-the-fact way. Thus, these predictions are macro-to-macro only. However, a micro-to-macro model significantly fails to predict correctly, as does the obvious mesoscopic modeling approach. This suggests that some macroscopic system properties in a complex dynamic system should be interpreted as examples of phenomena (properties) arising from "strong emergence," due to the lack of ability to build a consistent micro-to-macro model, that could explain these phenomena in a before-the-fact way. The root cause for this inability to predict this in a micro-to-macro way is identified as the pattern formation process, a phenomenon that is usually classified as being of "weak emergence." Ultimately, this suggests that it may be in principle impossible to discriminate between such distinct categories of "weak" and "strong" emergence, as phenomena of both types can be part of the very same feedback loop that mainly governs the system's dynamics.