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Critical Behavior in a Class of Heterogeneous Complex Systems[1]
SHABNAM HOSSEIN, FLORIAN GREIL, KEVIN E. BASSLER, Department of Physics, University of Houston — Dynamical critical behavior of a prototypical heterogeneous complex system, random Boolean networks, is studied. Using analytical arguments, we show that the networks, at the boundary between their frozen and chaotic dynamical phases, display universal critical behavior in their attractor period distribution, which has the functional form of a decaying power-law. Using a known result that nodes relevant to the dynamics on attractors at criticality can be divided into separate components, we analyze the structure of these relevant components and how their dynamics combine to find the distribution of attractor periods. This is accomplished by mapping the problem to the enumeration of binary Lyndon words. We show that the attractor period distribution becomes scale-free in the large network limit with a decay described by a critical exponent of 1. Results of numerical simulations that support this finding, but that also show that substantial finite-size corrections exist, will also be presented. The universal nature of this behavior is demonstrated by comparison to that of the evolved critical state achieved through the playing of an adaptive game that selects for diversity of node behavior.

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