Information fitness and the emergence of criticality in communities of living systems.

Miguel A- Muñoz
Institute "Carlos I" for Theoretical and Computational Physics, University of Granada

Abstract: Empirical evidence has proliferated that living systems might operate in the vicinity of critical points, at the borderline between order and disorder, with examples ranging from spontaneous brain activity to flock dynamics. A central unresolved issue is to understand how and why interacting living systems dynamically tune themselves to be poised in the vicinity of a critical point. Here we employ tools from statistical mechanics and information theory to show that complex adaptive or evolutionary systems can be much more efficient in coping with diverse heterogeneous environmental conditions when operating at criticality.
Analytical as well as computational evolutionary and adaptive models vividly illustrate that a community of such systems dynamically self-tunes close to a critical state as the complexity of the environment increases while they remain non-critical for simple and predictable environments. A more robust convergence to criticality emerges in co-evolutionary and co-adaptive set-ups in which individuals aim to represent other agents in the community with fidelity, thereby creating a collective critical ensemble and providing the best possible trade-off between accuracy and flexibility. Our approach provides a parsimonious and general mechanism for the emergence of critical-like behaviour in living systems needing to cope with complex environments or trying to efficiently coordinate themselves as an ensemble.

Reference: J. Hidalgo, J. Grilli, S. Sweis, M.A. Muñoz, J. Banavar and A. Maritan, Preprint 2014. Sumitted to PNAS (arXiv: 1307.4325)