Observing scale-invariance in non-critical dynamical systems

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Abstract

Scale invariant avalanches have been observed and discussed recently in the Brain. We point out, that these results do not necessarily imply that the properties of the underlying neural dynamics are also scale invariant. The reason for this discrepancy lies in fact that the sampling statistics of observations and experiments is generically biased by the size of the basins of attraction of the processes to be studied. One has hence to precisely define what one means with statements like 'the brain is critical'.

We propose a class of information routing models which are conserving and hence critical in the sense of statistical physics. We present the exact solution of these vertex routing models and show that the intrinsic dynamics is dominated by log-corrections, and does therefore not show scale invariance. These models are hence not critical in the sense that their intrinsic behavior is not scale invariant. We show that the statistics of a randomly drawn ensemble of processes, the standard setup in experimental investigations, does however exhibit scale invariance. We point out that an analogous situation occurs for random boolean networks and conclude that the implications of experimental observations of power laws needs to be reconsidered.

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