

## **Phase transitions and self-organized criticality in networks of stochastic spiking neurons**

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### **Resumo**

Phase transitions and critical behavior are crucial issues both in theoretical and experimental neuroscience. We report analytic and computational results about phase transitions and self-organized criticality (SOC) in networks with general stochastic neurons. The stochastic neuron has a firing probability given by a smooth monotonic function  $\Phi(V)$  of the membrane potential  $V$ , rather than a sharp firing threshold. We find that such networks can operate in several dynamic regimes (phases) depending on the average synaptic weight and the shape of the firing function  $\Phi$ . In particular, we encounter both continuous and discontinuous phase transitions to absorbing states. At the continuous transition critical boundary, neuronal avalanches occur whose distributions of size and duration are given by power laws, as observed in biological neural networks. We also propose and test a new mechanism to produce SOC: the use of dynamic neuronal gains - a form of short-term plasticity probably located at the axon initial segment (AIS) - instead of depressing synapses at the dendrites (as previously studied in the literature). The new self-organization mechanism produces a slightly supercritical state, that we called SOSOC, in accord to some intuitions of Alan Turing.