Neuronal Avalanches in the Transition Between an Active and an Oscillatory Phase?

Leonardo Dalla Porta[1] and Mauro Copelli[1]

[1]Universidade Federal de Pernambuco, Recife/BR

Neuronal avalanches are bouts of spontaneous spatio-temporal activity with complex emergent properties. The probability distributions of avalanche size and duration decay as power laws $P(s) \sim s^{-3/2}$ and $P(s) \sim d^{-2}$, respectively, suggesting that the network is operating near a critical point [1].

Models from directed percolation universality class (DP) have been widely used to explain the scale invariant statistic of neuronal avalanches. However, these models do not take into account the dynamics of inhibitory neurons and besides that, as they present a phase transition between an absorbing state and an active phase, it is difficult to reconcile the model with long-range temporal correlations that are observed experimentally at different spatial scales [2, 3].

Poil et al., in an attempt to address some of these issues, proposed a computational model of excitatory and inhibitory neurons in a two-dimensional disordered network. They claim that their model shows a phase transition between an active and an oscillatory phase. At the critical line in parameter space, oscillations and neuronal avalanches emergent jointly. Moreover, detrended fluctuation analysis suggest that long-range time correlations ($1/f$ noise) also appear at the critical line [4].

In the present study we have studied this model further. We have analyzed the model's robustness against changes in system size, interaction range and the activity threshold that defines an avalanche. Besides the analysis of temporal autocorrelation, we proposed a order parameter seeking for more evidences of a phase transition.

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