Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Data collapse and critical dynamics in neuronal avalanche data

THOMAS BUTLER, Massachusetts Institute of Technology, NIR FRIEDMAN, KARIN DAHMEN, University of Illinois at Urbana-Champaign, JOHN BEGGS, Indiana University, LEE DEVILLE, University of Illinois at Urbana-Champaign, SHINYA ITO, Indiana University — The tasks of information processing, computation, and response to stimuli require neural computation to be remarkably flexible and diverse. To optimally satisfy the demands of neural computation, neuronal networks have been hypothesized to operate near a non-equilibrium critical point. In spite of their importance for neural dynamics, experimental evidence for critical dynamics has been primarily limited to power law statistics that can also emerge from non-critical mechanisms. By tracking the firing of large numbers of synaptically connected cortical neurons and comparing the resulting data to the predictions of critical phenomena, we show that cortical tissues in vitro can function near criticality. Among the most striking predictions of critical dynamics is that the mean temporal profiles of avalanches of widely varying durations are quantitatively described by a single universal scaling function (data collapse). We show for the first time that this prediction is confirmed in neuronal networks. We also show that the data have three additional features predicted by critical phenomena: approximate power law distributions of avalanche sizes and durations, samples in subcritical and supercritical phases, and scaling laws between anomalous exponents.

Thomas Butler
Massachusetts Institute of Technology

Date submitted: 16 Nov 2011 Electronic form version 1.4