MAR10-2009-020225

Abstract for an Invited Paper
for the MAR10 Meeting of
the American Physical Society

Balanced excitation and inhibition lead to statistical and dynamical criticality

GUILLERMO CECCHI, IBM Research

We present a simple abstract model, an anti-Hebbian network which spontaneously poises itself, by balancing excitation and inhibition, at a dynamically critical state: an extensive number of degrees of freedom approach Hopf bifurcations, becoming arbitrarily sensitive to external perturbations (PRL 102, 258102 - 2009). As the dynamics controlling this state has itself a marginal fixed point, the eigenvalues fluctuate close to the imaginary axis; when they become slightly unstable, the corresponding mode "breaks out" and becomes more prominent, and as they become slightly stable the mode slowly damps out. This breakout dynamics displays avalanche-like activity bursts whose sizes may be power-law distributed, i.e. statistically critical. Within these epochs the neurons of our model are slightly correlated; yet, as the number of small but significant correlations is high, the model has strongly correlated network states. This system is, on the short time-scale, sensitive in bulk to any outside input, even if applied only to a small subset of the neurons. We also present preliminary results showing that human brain electro-physiological recordings display both statistical and dynamical criticality.