

POSTER PRESENTATION

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Self-organized criticality in a model for developing neural networks

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Recent experiments have observed a dynamical state characterized by so-called neural avalanches in different neural systems, such as networks of cultured neurons [1], the developing retina [2] and the neocortex in vivo [3]. Neural avalanches are bursts of activity that have power-law size distribution, which suggests that the system has assumed a critical state. To investigate how such a state might develop, we study neural network growth models that were proposed on the basis of neurobiological experiments [4,5]. In these models, the spiking activity of a neuron governs the outgrowth of its processes and the spatial overlap between neuronal processes determines the coupling strengths. We show analytically that an appropriately modified version of these models self-organizes into a state where it generates critical spiking activity and neural avalanches, i.e. the network grows into criticality. The conditions under which this happens are studied analytically and numerically. We complement our findings by investigating the structural and dynamical properties of the network, such as the lengths of neural protrusions in different one- and two-dimensional spatial arrangements and the temporal correlations between avalanche shapes and sizes, during development and in the critical state.

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References

1. Beggs JM, Plenz D: Neuronal Avalanches in Neocortical Circuits. *J Neurosci* 2003, **23**(35):11167-11177.

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2. Hennig MH, Adams C, Willshaw D, Sernagor E: Early-Stage Waves in the Retinal Network Emerge Close to a Critical State Transition between Local and Global Functional Connectivity. *J Neurosci* 2009, **29**(4):1077-1086.
3. Petermann T, Thiagarajan TC, Lebedev MA, Nicoletis MAL, Chialvo DR, Plenz D: Spontaneous cortical activity in awake monkeys composed of neuronal avalanches. *Proc Natl Acad Sci U S A* 2009, **106**:15921-15926.
4. van Ooyen A, van Pelt J: Activity-dependent Outgrowth of Neurons and Overshoot Phenomena in Developing Neural Networks. *J theor Biol* 1994, **167**:27-43.
5. Abbott LF, Rohrkeper R: A simple growth model constructs critical avalanche networks. *Prog Brain Res* 2007, **165**:13-19.

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