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On the Emergent Properties of Recurrent Neural Networks at Criticality YAHYA KARIMIPANAH, ZHENGYU MA, RALF WESSEL, Washington University in St. Louis — Irregular spiking is a widespread phenomenon in neuronal activities in vivo. In addition, it has been shown that the firing rate variability decreases after the onset of external stimuli. Since these are known as two universal features of cortical activity, it is natural to ask whether there is a universal mechanism underlying such phenomena. Independently, there has been mounting evidence that superficial layers of cortex operate near a second-order phase transition (critical point), which is manifested in the form of scale free activity. However, despite the strong evidence for such a criticality hypothesis, it is still very little known on how it can be leveraged to facilitate neural coding. As the decline in response variability is regarded as an essential mechanism to enhance coding efficiency, we asked whether the criticality hypothesis could bridge between scale free activity and other ubiquitous features of cortical activity. Using a simple binary probabilistic model, we show that irregular spiking and decline in response variability, both arise as emergent properties of a recurrent network poised at criticality. Our results provide us with a unified explanation for the ubiquity of these two features, without a need to exploit any further mechanism.

Yahya Karimipanah
Washington University in St. Louis

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