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Dynamical criticality in the collective activity of a neural population

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The past decade has seen a wealth of physiological data suggesting that neural networks may behave like critical branching processes. Concurrently, the collective activity of neurons has been studied using explicit mappings to classic statistical mechanics models such as disordered Ising models, allowing for the study of their thermodynamics, but these efforts have ignored the dynamical nature of neural activity. I will show how to reconcile these two approaches by learning effective statistical mechanics models of the full history of the collective activity of a neuron population directly from physiological data, treating time as an additional dimension. Applying this technique to multi-electrode recordings from retinal ganglion cells, and studying the thermodynamics of the inferred model, reveals a peak in specific heat reminiscent of a second-order phase transition.