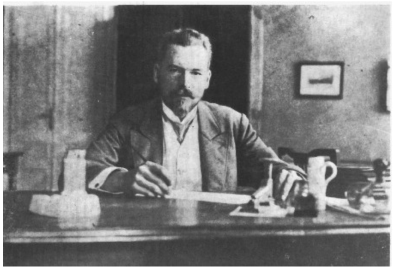

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# Dynamical mean field theory of neural networks with power-law disorder

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Transitions to chaos have been previously extensively studied in different setups of randomly connected networks. The prevailing assumption is that, due to the central limit theorem, synaptic input can be modeled as a Gaussian random variable. In this scenario, a continuous transition has been found in rate models with smooth activation functions. However, these models do not take into account that neurons feature thresholds that cut off small inputs. With such thresholds, the transition to chaos in Gaussian networks becomes discontinuous, making it impossible for the network to stay close to the edge of chaos and to reproduce biologically relevant low activity states.

Here we introduce a model with biologically motivated, heavy-tailed distribution of synaptic weights and analytically show that it exhibits a continuous transition to chaos. Notably, in this model the edge of chaos is associated with well-known avalanches. We validate our predictions in simulations of networks of binary as well as leaky integrate and fire neurons. Our results uncover an important functional role of non-Gaussian distributions of synaptic efficacy and suggest that their heavy tails may form a weak sparsity prior that can be useful in biological and artificial adaptive systems.

## Summary

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