Signal integration enhances the dynamic range in neuronal systems

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The dynamic range measures the capacity of a system to discriminate the intensity of an external stimulus. Such an ability is fundamental for living beings to survive: to leverage resources and to avoid danger. Consequently, the larger is the dynamic range, the greater is the probability of survival. We investigate how the integration of different input signals affects the dynamic range, and in general the collective behavior of a network of excitable units. By means of numerical simulations and a mean-field approach, we explore the nonequilibrium phase transition in the presence of integration. We show that the firing rate in random and scale-free networks undergoes a discontinuous phase transition depending on both the integration time and the density of integrator units. Moreover, in the presence of external stimuli, we find that a system of excitable integrator units operating in a bistable regime largely enhances its dynamic range.

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