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Critical behavior of large maximally informative neural populations[1] JOHN BERKOWITZ, Univ of California - San Diego, TATYANA SHARPEE, Computational Neurobiology Laboratory, Salk Institute for Biological Studies, La Jolla, CA; Department of Physics, University of California, San Diego — We consider maximally informative encoding of scalar signals by neural populations. In a small time window, neural responses are binary, with spiking probability that follows a sigmoidal tuning curve. The width of the tuning curve represents effective noise in neural transmission. Previous analyses of this problem for relatively small numbers of neurons with identical noise parameters indicated the presence of multiple bifurcations that occurred with decreasing noise value. For very high noise values, maximal information is achieved when all neurons have the same threshold values. With decreasing noise, the threshold values split into two or more groups via a series of bifurcations, until finally each neuron has a different threshold. Analyzing this problem in the large N limit, we found instead that there is a single phase transition from redundant coding to coding based on distributed thresholds. The order parameter of this transition is the threshold standard deviation across the population; differences in noise parameter from the mean are analogous to local magnetic fields. Near the bifurcation point, information transmitted follows a Landau expansion. We use this expansion to quantify the scaling of the order parameter with noise and effective magnetic field.

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