

# *N*neurons $\rightarrow \infty$

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Simultaneous recordings from tens of thousands of neurons allow a new framework for characterizing the neural code at large scales. As the number of neurons analyzed increases, population activity approximates a vector in an infinite-dimensional Hilbert space. In this limit, the independent activity of any single neuron is of no consequence, and the neural code reflects only activity dimensions shared across the population. Analyzing the responses of large populations in mouse visual cortex to natural image stimuli revealed an unexpected result: signal variance in the  $n^{\text{th}}$  dimension decayed as a power law, with exponent just above 1. We proved mathematically that a differentiable representation of  $d$ -dimensional stimulus requires variances decaying faster than  $n^{-1-2/d}$ . By recording neural responses to stimulus ensembles of varying dimension, we showed this bound is close to saturated. We conclude that the cortical representation of image stimuli is as high-dimensional as possible before becoming non-differentiable.