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Mapping Visual Stimuli to Perceptual Decisions via Sparse Decoding of Mesoscopic Neural Activity

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Abstract— **In this talk I will describe our work investigating sparse decoding of neural activity, given a realistic mapping of the visual scene to neuronal spike trains generated by a model of primary visual cortex (V1). We use a linear decoder which imposes sparsity via an L1 norm. The decoder can be viewed as a decoding neuron (linear summation followed by a sigmoidal nonlinearity) in which there are relatively few non-zero synaptic weights. We find: (1) the best decoding performance is for a representation that is sparse in both space and time, (2) decoding of a temporal code results in better performance than a rate code and is also a better fit to the psychophysical data, (3) the number of neurons required for decoding increases monotonically as signal-to-noise in the stimulus decreases, with as little as 1% of the neurons required for decoding at the highest signal-to-noise levels, and (4) sparse decoding results in a more accurate decoding of the stimulus and is a better fit to psychophysical performance than a distributed decoding, for example one imposed by an L2 norm. We conclude that sparse coding is well-justified from a decoding perspective in that it results in a minimum number of neurons and maximum accuracy when sparse representations can be decoded from the neural dynamics.**

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