Decoding Visual Images from Neuronal Calcium Responses Using Deep Neural Networks

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Presentation Abstract Summary One of the open questions of neuroscience is how sensory stimuli are encoded by neurons and conversely, how sensory stimuli can be decoded from neuronal activity. Various techniques exist for measuring neural responses to sensory stimuli. A recent technique employs genetically encoded fluorescent calcium indicators (GCaMPs) which can be selectively expressed in discrete cell types and brain regions to measure neuronal activity in behaving animals. The Allen Institute for brain science recently published an extensive data set of cell-type specific GCaMP6 activity from the parcellated mouse visual cortex collected in response to a wide variety of visual stimuli (http://observatory.brain-map.org/visualcoding; Hawrylycz, et al. 2016). Here we leverage this publicly available database and deep neural networks to show that a proximal measure of neuronal activity (GCaMP6 signal) can be used to decode, with high accuracy and specificity, a wide variety of visual stimuli. Importantly, the highest accuracy was obtained by implementing a simple deep neural network architecture. In sum, our approach demonstrated the applicability of deep learning to sensory decoding using calcium imaging data and highlights the low requirement of architecture complexity for successful decoding in this experimental context.

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Keywords

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