Reconstruction of natural images from responses of primate retinal ganglion cells

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Background

Visual signaling by the retina is often probed by studying how retinal ganglion cells (RGCs) encode the visual stimulus. A complementary approach is to reconstruct the stimulus from RGC responses (1-3). This provides a view of what information RGCs transmit about the visual scene in the domain of the stimulus, rather than neural responses.

Here, we investigate reconstruction from primate RGCs.

Methods

Populations of retinal ganglion cells were recorded using a large-scale multielectrode array in peripheral macaque retina ex vivo.

Linear Reconstruction

Least squares regression was performed to calculate reconstruction filters. Reconstruction performance was calculated by predicting the stimulus on held-out data.

Data was collected from three preparations of retina (images, ON parasol cells, OFF parasol cells; 7200, 58, 72, (1600x3, 74, 74), (1700x4, 62, 44). Estimates of the model parameters W were close to asymptotic in the amount of data.

Model performance was measured over region covered by RGCs.

How do ON and OFF cell types represent the image?

Reconstruction using ON vs. OFF parasol cells alone can’t distinguish low pixel intensities.

Reconstruction using ON + OFF parasol cells can’t distinguish low pixel intensities.

Reconstruction using only ON cells failed to accurately capture dark areas of the image, and vice versa.

ON and OFF populations encode different ranges of contrast, and both are needed to reconstruct the image.

Is the spatial signal independent?

Using cell responses from different trials doesn’t affect reconstruction, suggesting that correlated activity is not being used.

What is the spatial message sent by a RGC?

Reconstruction filters resemble white noise STA with hints of natural scenes structure.

References


Future Work

- building on the linear model
- incorporating more cell types
- further investigation of the visual message and independence
- spatiotemporal reconstructions.

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