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Title of your presentation / abstract

A Generative Model of Decorrelating Color Sensitive Retinal Ganglion Cells

Assignment / Keywords

Assignment:	T15 - Vision: Retina and Subcortical Pathways
Keyword 1:	CODING
Keyword 2:	RETINAL GANGLION CELL
Keyword 3:	VISION

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Body of your presentation / abstract

Neuroanatomical studies have shown that the mammalian retina consists of many parallel, equally potent microcircuits [3] which in turn drive numerous different retinal ganglion cell (RGC) types, indicating the retina's functional role of pre-processing visual-information before reaching the visual cortex. Theoretical models suggest that the retina encodes information efficiently, using minimal resources whilst transmitting a maximum of information [1].

Generative Model
The effect of minimizing metabolic costs had been explored by [4] utilizing a generative model with one hidden layer. In this simple model connection weights are equated to synaptic strengths and the network's output to neural firing rates. By reconstructing the input from hidden layer activity and by comparing reconstruction and original input an error signal is generated, which in turn is used to update the networks weights. Also, a weight constraint is applied. Constraining the connection strengths in this model is crucial for the emergence of localized, difference of Gaussian (DOG) shaped receptive fields, resembling those of retinal ganglion cells (RGC).

Extension to Color
We extended the model, which processes gray scale images [4], to color images. Additionally the hidden layer neural activations were only allowed to be positive and the imposed weight constraint was simplified by removing one threshold parameter. After the training process converged, the receptive fields were first fitted with a spatio-chromatic elliptical DOG parametric model and then clustered via k-means into 7 clusters.

Decorrelation of Input
The resulting receptive fields decorrelate the input into several distinct channels each spanning the entire simulated visual field, resembling parallel pathways [2] found in the primate retina. As a consequence of applying the weight constraint continuously, receptive fields not contributing to reconstructing the presented images slowly die off (their weights decay to zero). An efficient code emerges that uses a small number of RGC neurons and small weights to encode the presented input. However, slightly different model parameters, or training images with different overall statistics, tend to result in vastly different distributions of RGCs.

The Figure shows parametric fits of the resulting receptive fields for 6 of the 7 clusters. Ellipses are drawn in the color of the strongest weight for each RGC. As the model has been trained from rgb images, the color of these center weights is mostly close to the rgb color space cube's edges. (Top row: red, green, blue. Bottom row: cyan (red-off), magenta (green-off), yellow (blue-off).) The 7th cluster contains non-local, non-DOG shaped receptive fields. The numbers of RGCs in each channel are: red (47), green (38), blue (60), cyan (48), magenta (38), yellow (63), non-DOG (26), zero (256), total (576).

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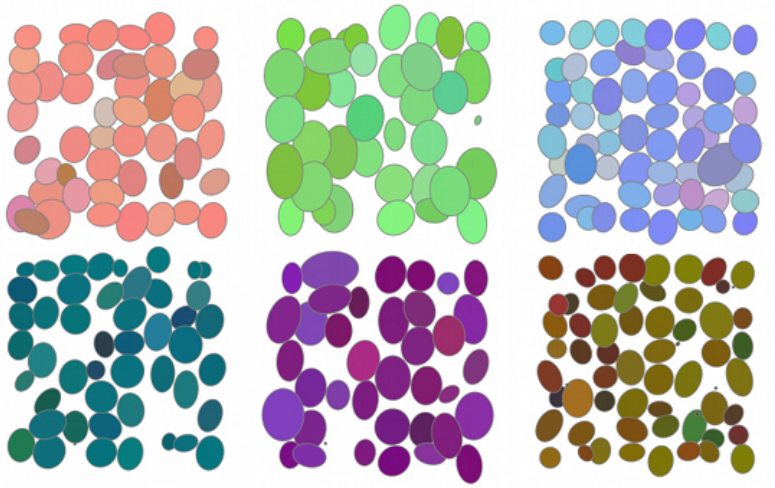
Figure



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