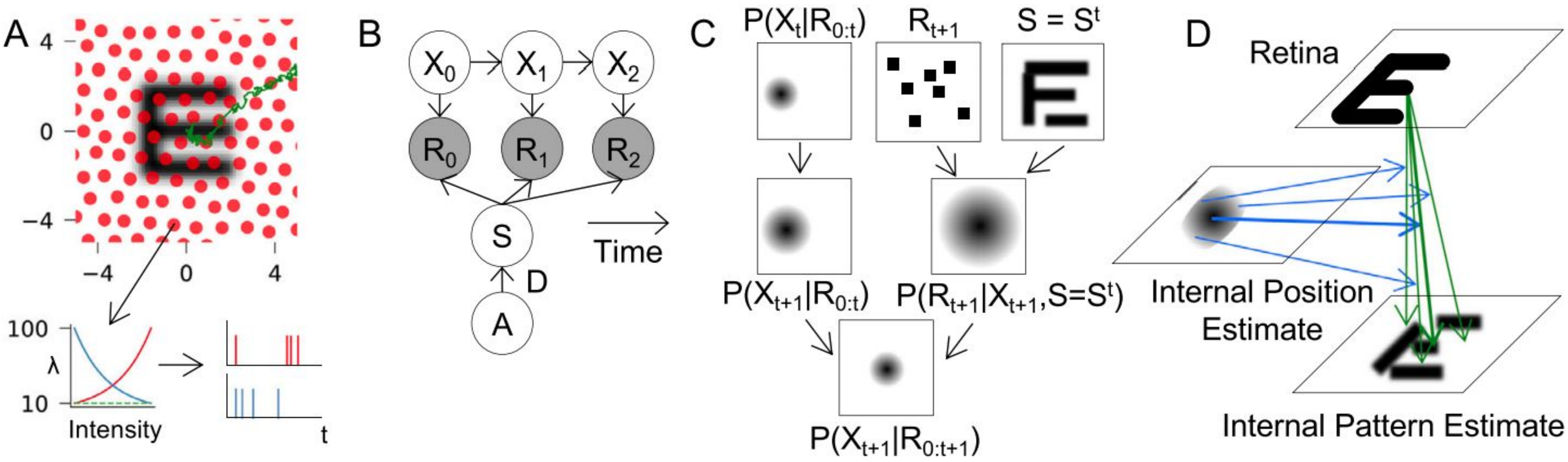
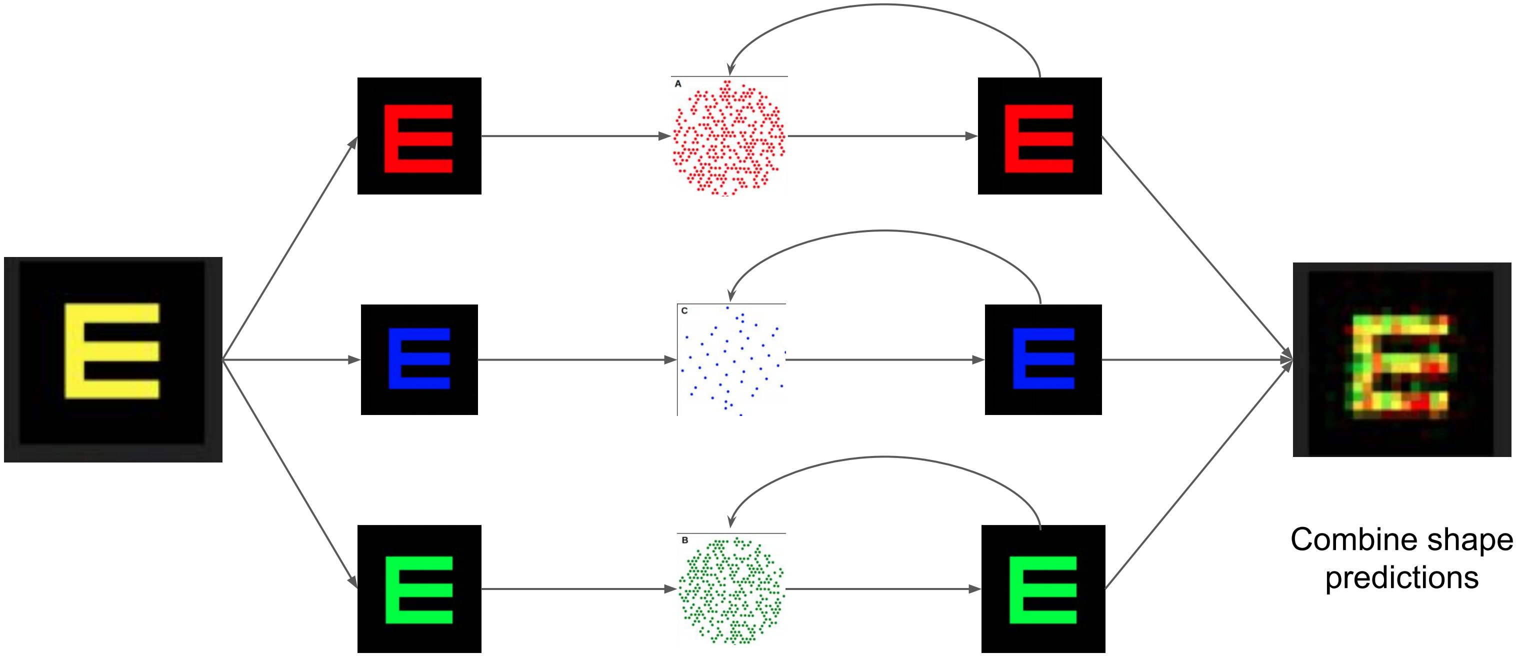
# The Effect of Lateral Inhibition on Color Perception

Navneedh Maudgalya
Rishi Upadhyay
Nithin Raghavan

# Recap of Anderson Model



# Recap of Last Year's Extension to Anderson Model




Combine shape predictions

Split image into RGB/oRGB channels

Move each cone mosaic in same direction and measure RGC activations

Infer the retina position and the shape of the image in each channel

# Transforming Input from RGB to LMS space

- R, G, and B values do not correspond to activations of L, M, and S cones
- We want to represent the RGB image in LMS space before running the model
- To start, we can convert RGB -> XYZ -> LMS color spaces
    - Simulates the response of the cones in the eye
    - Corresponds to actual cones better
- Previous model did color opponency model with RGB -> oRGB, but that assumes that each cone corresponds directly to each opponent spaces.

$$\begin{bmatrix} L \\ M \\ S \end{bmatrix} = \begin{bmatrix} 0.8562 & 0.3372 & -0.1934 \\ -0.8360 & 1.8327 & 0.0033 \\ 0.0357 & -0.0469 & 1.0112 \end{bmatrix} \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 0.418\,47 & -0.158\,66 & -0.082\,835 \\ -0.091\,169 & 0.252\,43 & 0.015\,708 \\ 0.000\,920\,90 & -0.002\,549\,8 & 0.178\,60 \end{bmatrix} \cdot \begin{bmatrix} X \\ Y \\ Z \end{bmatrix}$$

# Accounting for Lateral Inhibition

Anderson model:

$$c_{j,t} = g \cdot \sum_i S_i T(X_t^R)_{i,j}$$

Our model:

$$c_{j,t} = g \cdot \max\left(\sum_i S_i T(X_t^R)_{i,j} - \sum_{k \in \mathcal{N}} \sum_i S_i I(j,k), 0\right)$$

$$I(j,k) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{||X_j - X_k||}{\sigma}\right)^2}$$

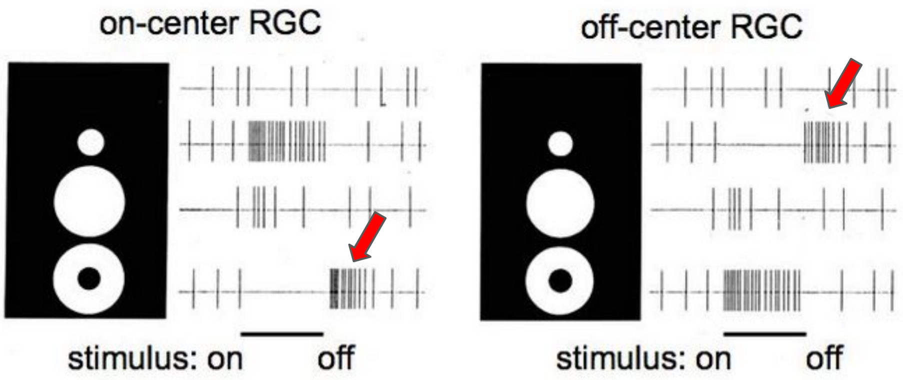
Key differences: $\max$, $N$ (set of neighboring cones), $I$ (distance function)

Similarities: $g$ (gain), activation of original cone

Final value of $c_{j,t}$ is transformed and used to calculate final frequency of firing

# Accounting for Lateral Inhibition (con't)

Issue:




Need to include a temporal aspect to activation and firing frequency

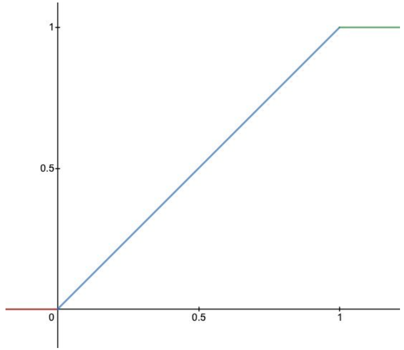
Modifications:

$$c_{j,t} = g \cdot \left( \sum_i S_i T(X_t^R)_{i,j} - \sum_{k \in \mathcal{N}} \sum_i S_i I(j,k) \right)$$

$$c'_{j,t} = c_{j,t} \text{ if } j \in \text{ON or } 1 - c_{j,t} \text{ if } j \in \text{OFF}$$

$$c''_{j,t} = c'_{j,t} + \sum_{q=0}^{t'} \max\left(c'_{j,t} - c'_{j,t-q}, 0\right)$$

$c''_{j,t}$ $\Rightarrow$




$\Rightarrow$ $c_f$

# Jointly Inferring Shape and Color

- Anderson model infers shape, S, according to S = DA where D is a dictionary of basis functions and A is the inferred latent variable
- We can modify D to represent a spatio-chromatic basis to construct colored shapes
  - For reconstruction purposes doesn't make sense to infer color and shape independently
- **Next Step:** Looking for biologically plausible dictionaries that can represent colored images and substituting such a dictionary into the model.

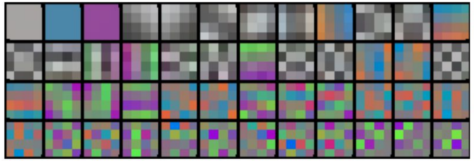
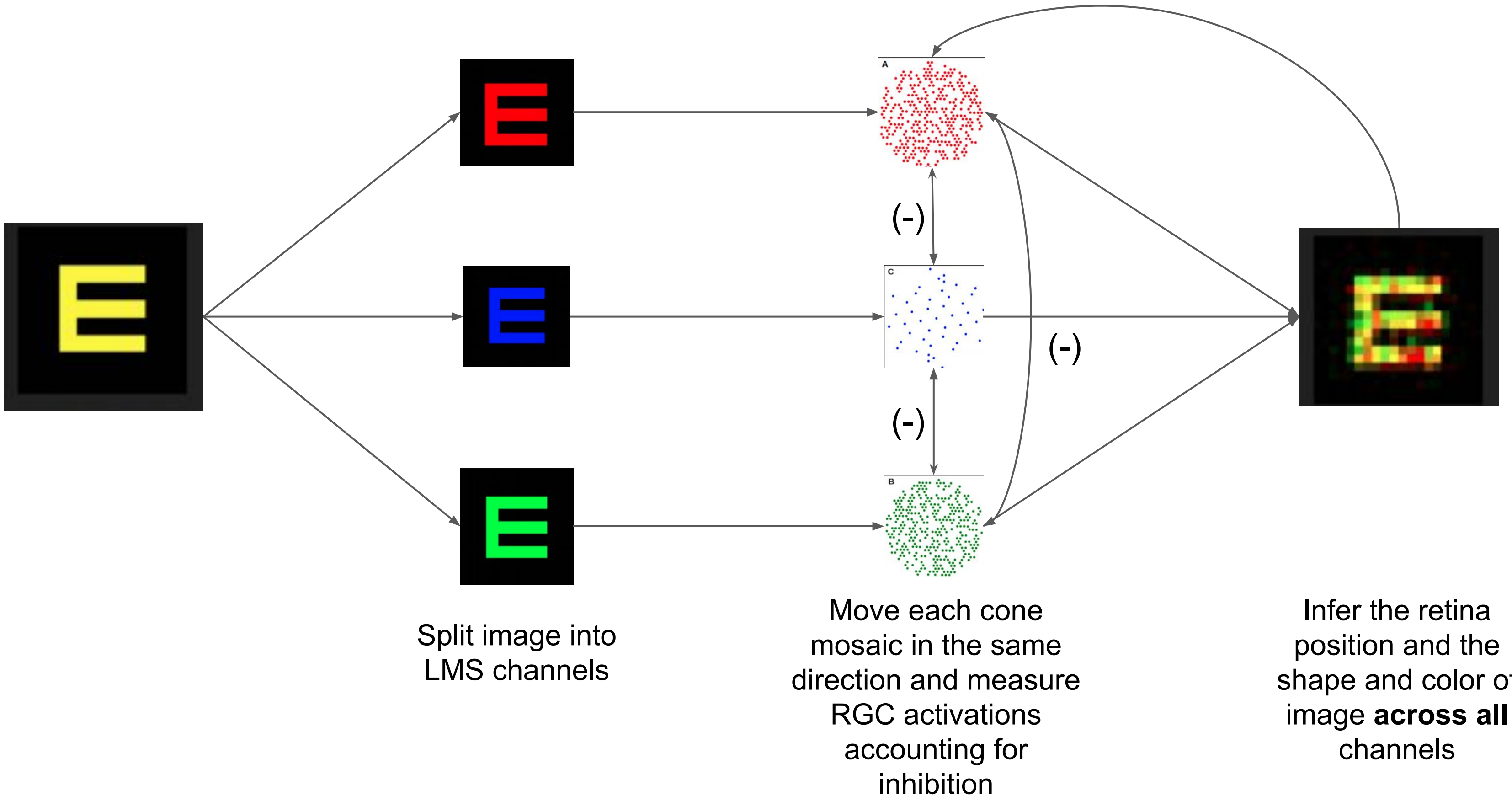


Figure 2: Spatio-chromatic basis obtained from PCA on $4 \times 4 \times RGB$ image patches of the example in Fig. 1.


A
C
B
(-)
(-)
(-)
Split image into LMS channels
Move each cone mosaic in the same direction and measure RGC activations accounting for inhibition
Infer the retina position and the shape and color of image **across all** channels

# Next Steps

- Modifying the RGC model equations in the Anderson model to incorporate lateral inhibition
- Locating and modifying the relevant code in Anderson’s code in order to incorporate lateral inhibition
- Modifying the sparse dictionary to include color and shape so that they are not inferred separately