

Exercise 6

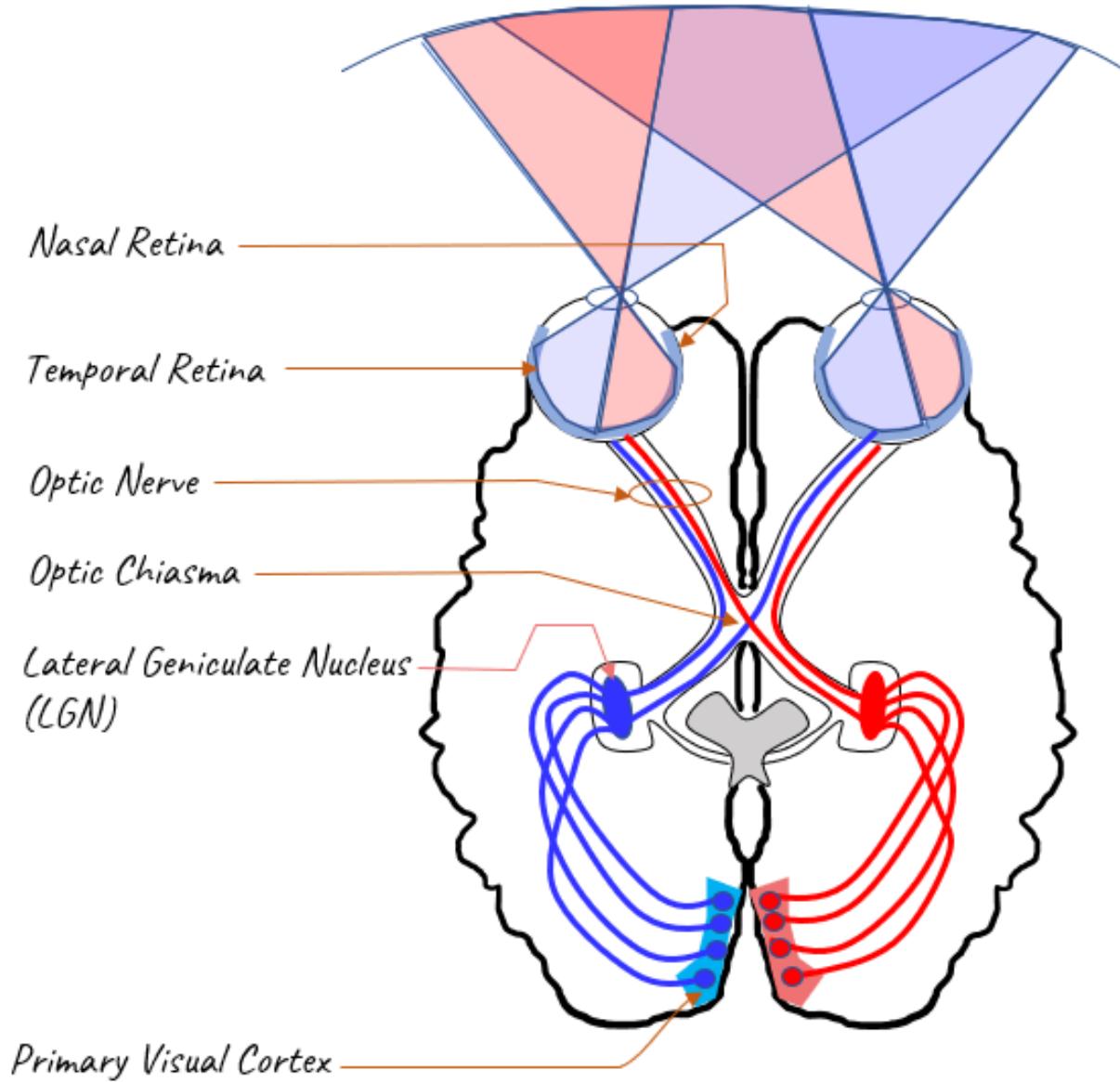
BIOENG-310: Neuroscience Foundations for Engineers

Yingtian Tiang

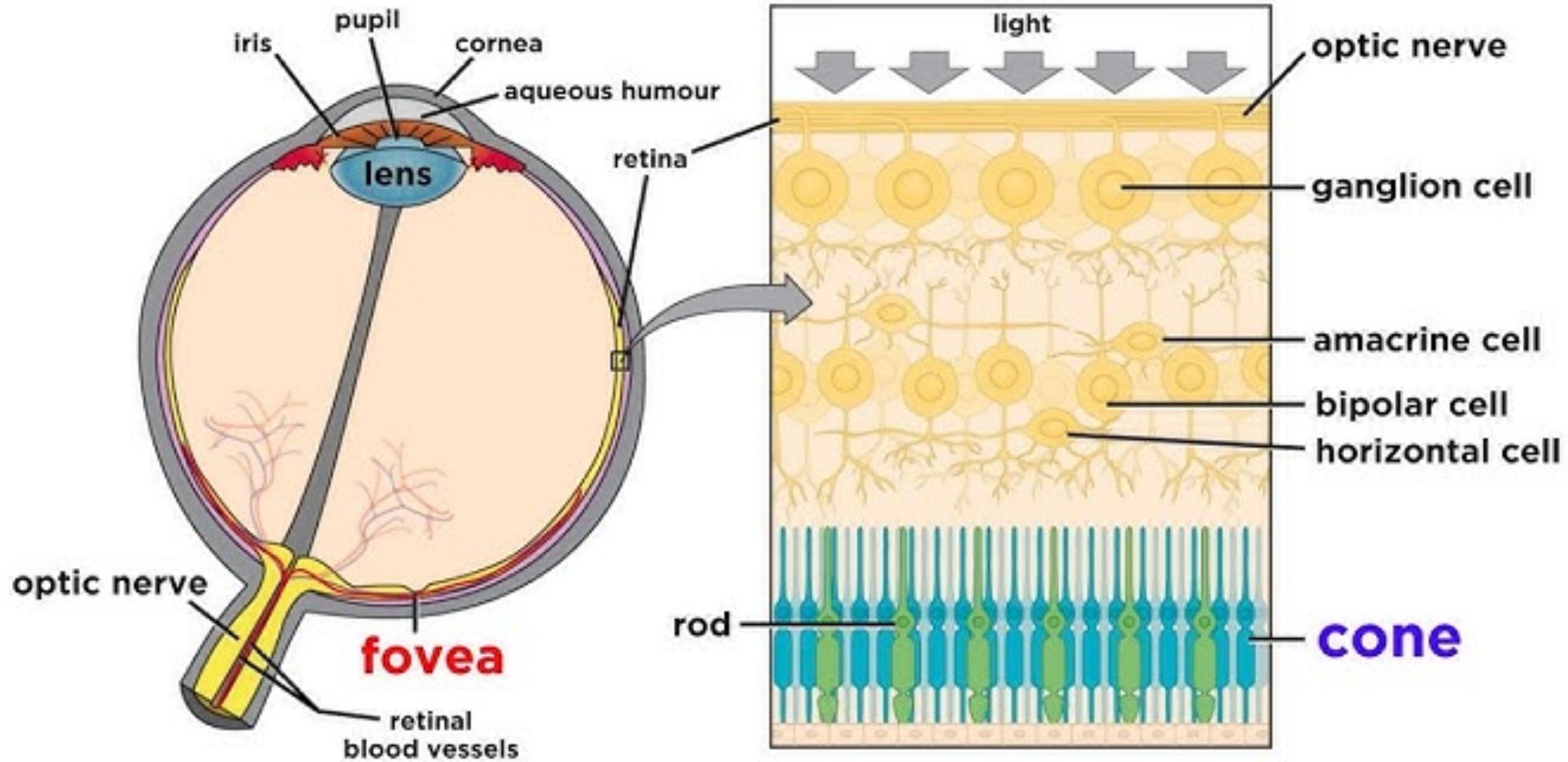
Alejandro Rodriguez Guajardo

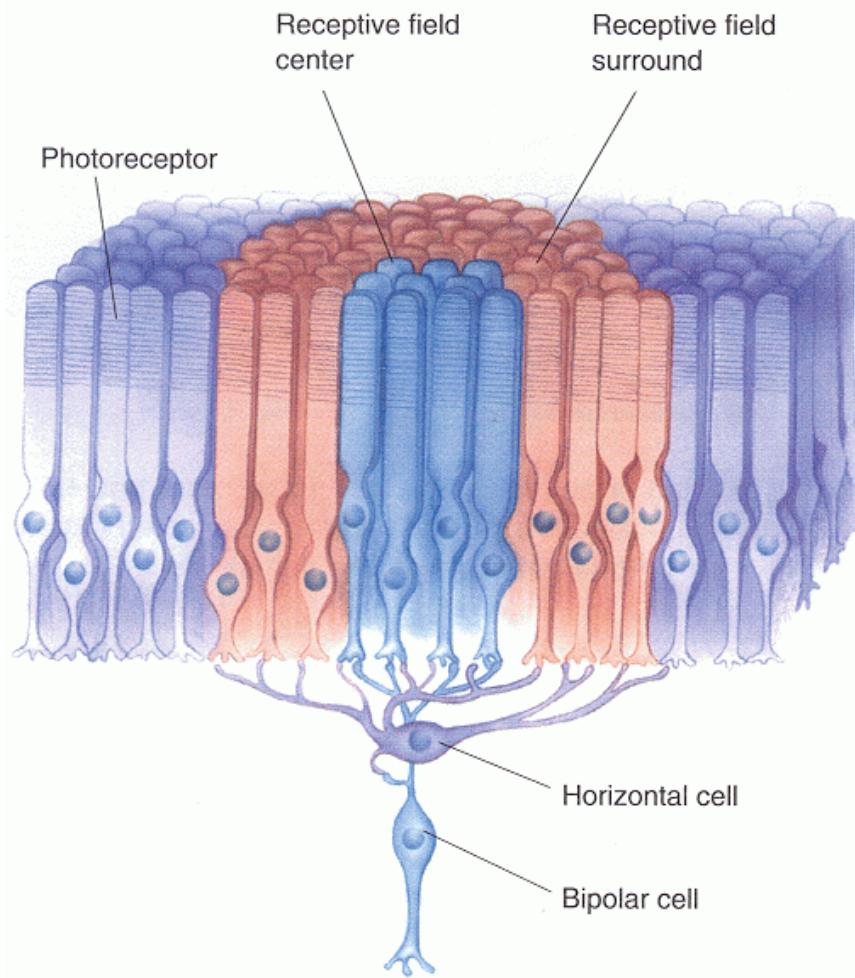
Context of the Exercise

- We will use a dataset from Freeman & Ziemba, 2013, a study on V1 and V2 responses to visual textures in macaque monkeys.
- **Objective:** Learn how to create and manipulate Gabor filters and RDM
 1. **Gabor filtering:** construct Gabor filters (lots of work)
 2. **Alignment between Gabor filtering and monkey V1 activity:** using RDMs to compare Gabor features and V1 activities

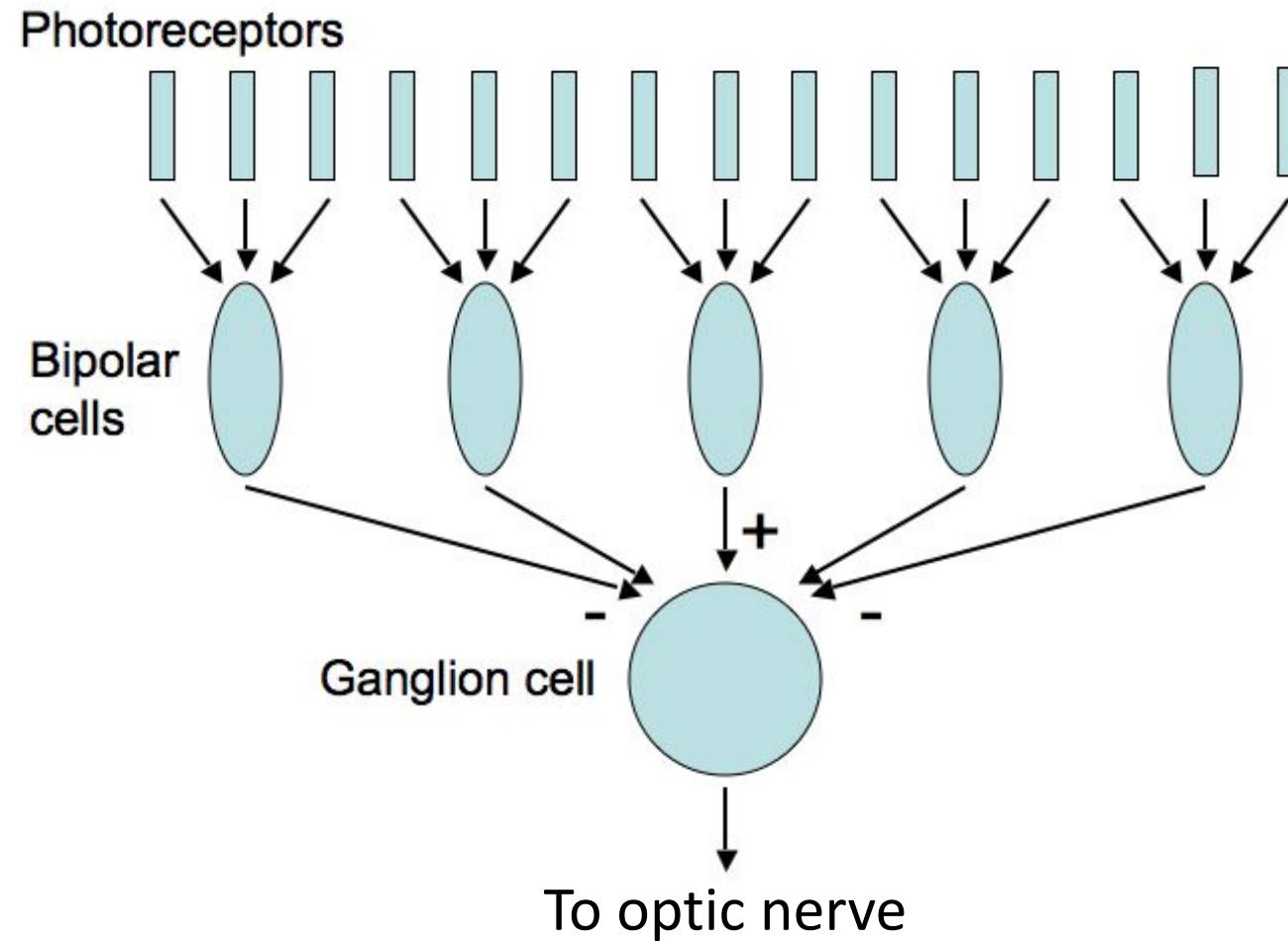


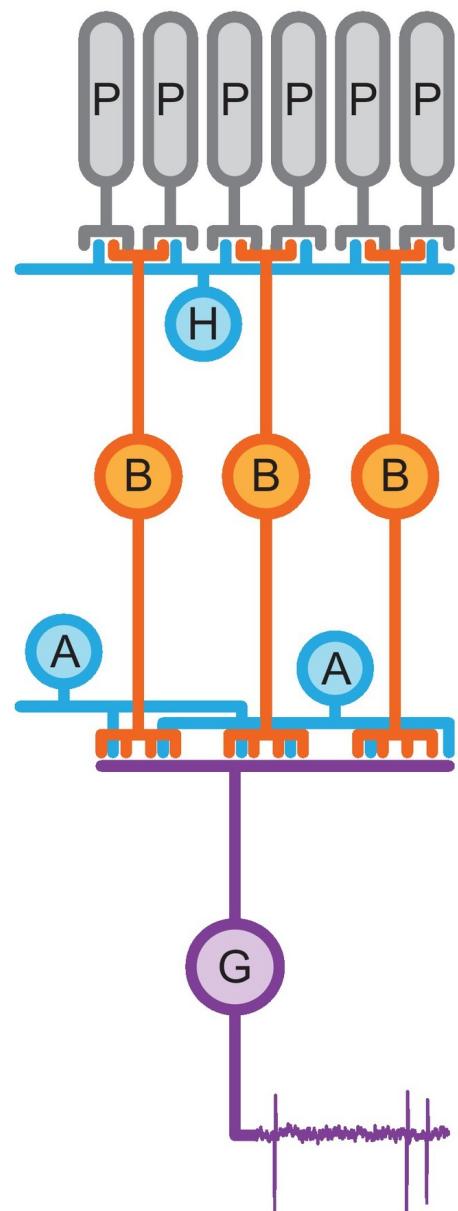
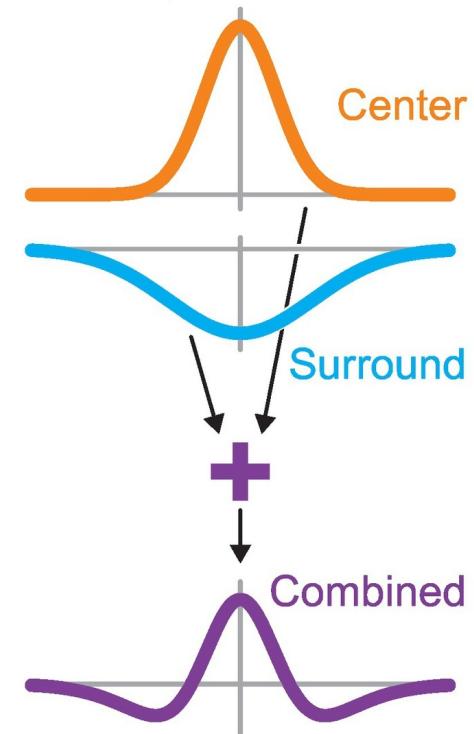
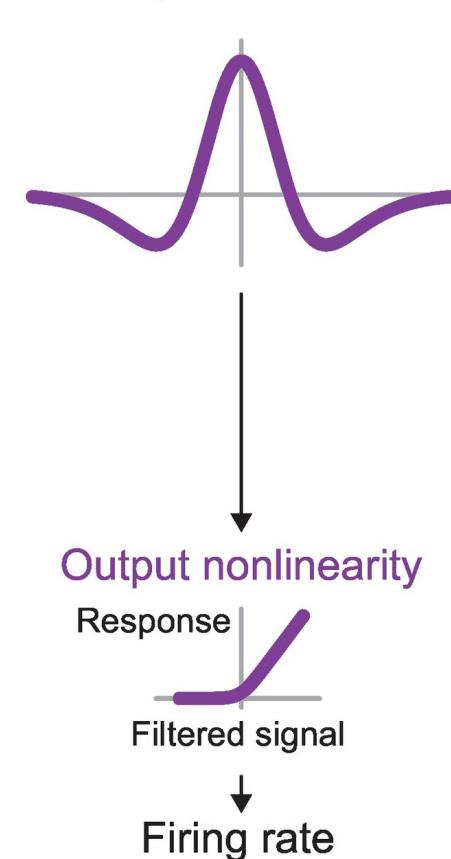
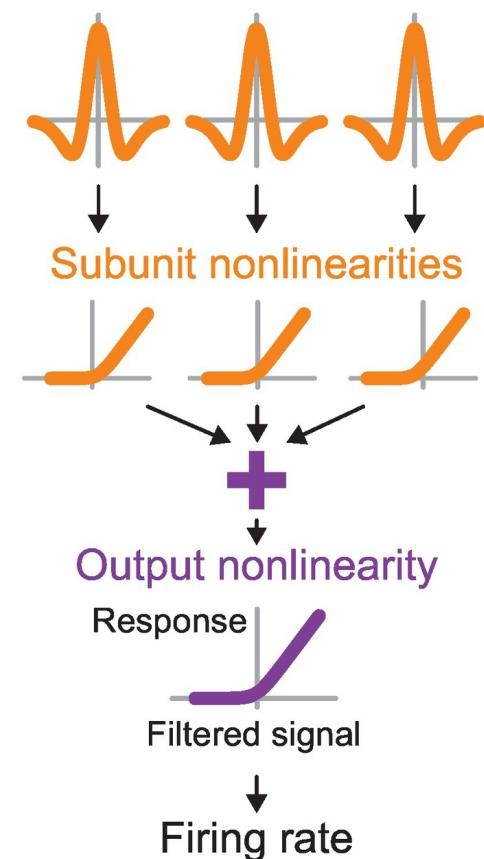
Overview of the visual system

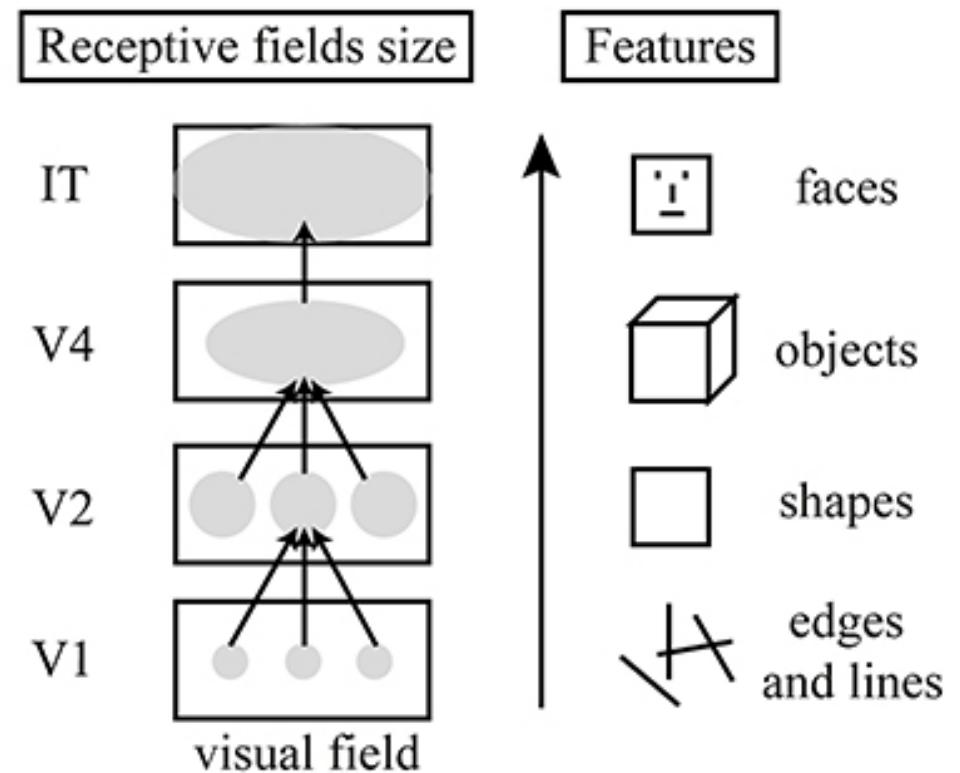
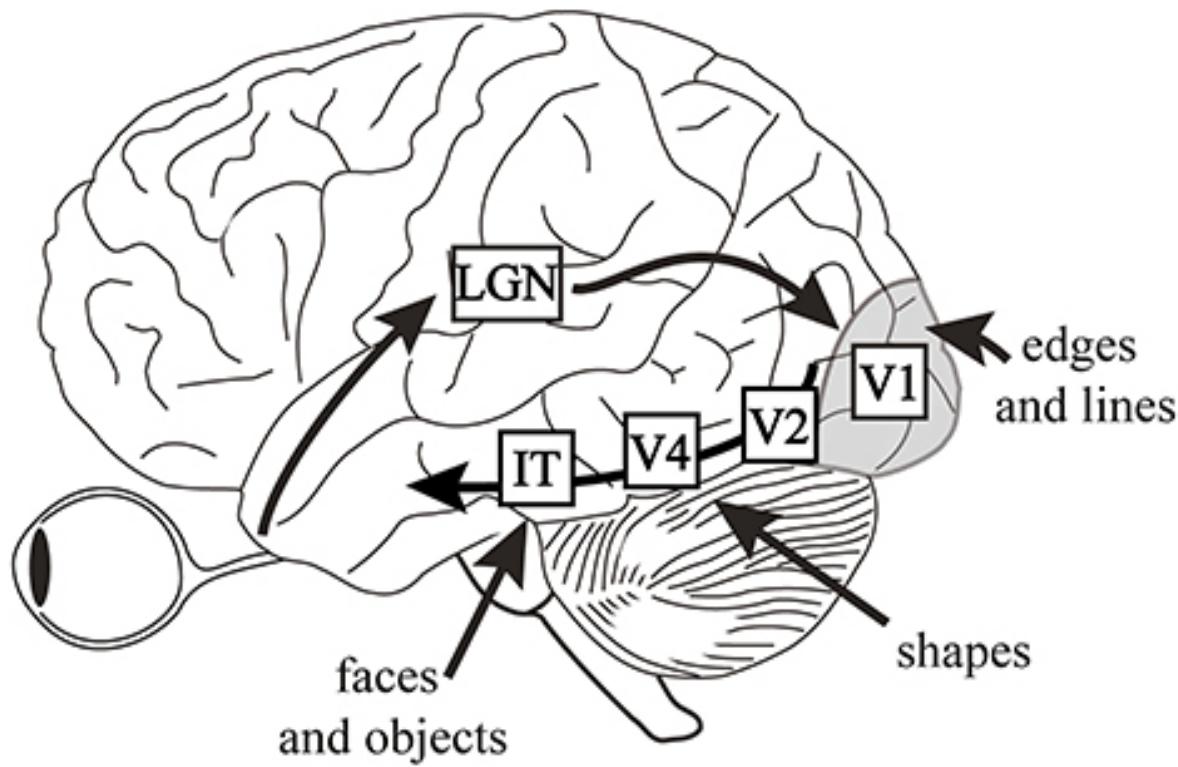




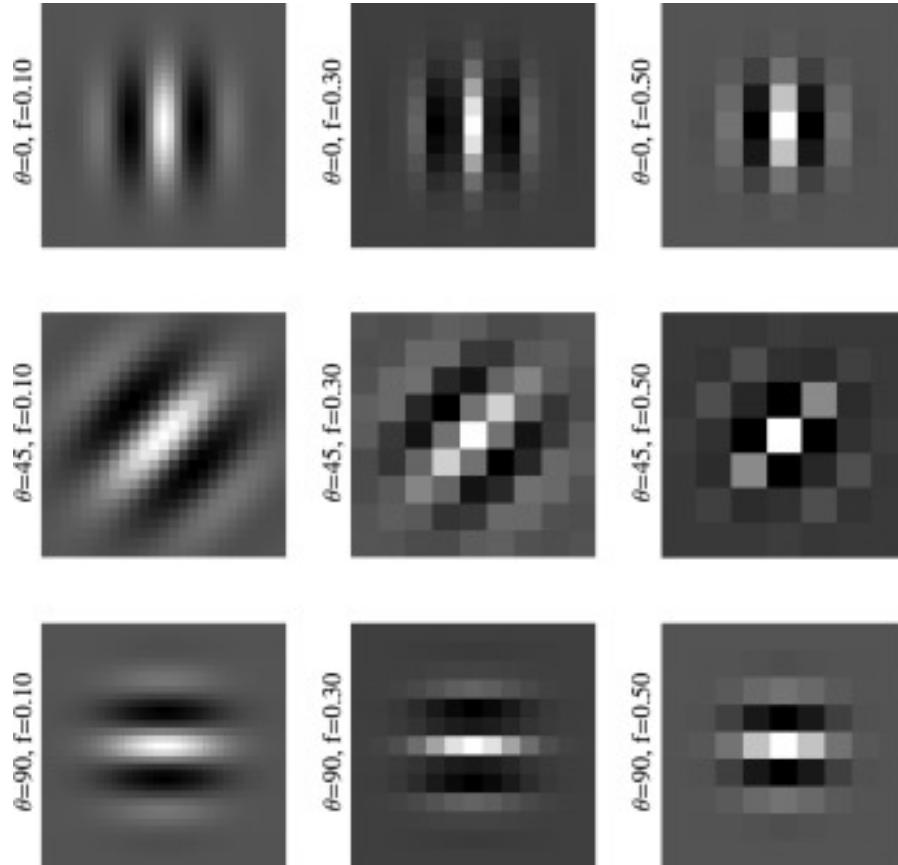
Linear receptive field model



(A)**Retinal circuitry****(B)****Receptive field****Spatial filter****(C)****LN model****Spatial filter****(D)****Subunit model****Subunit filters**

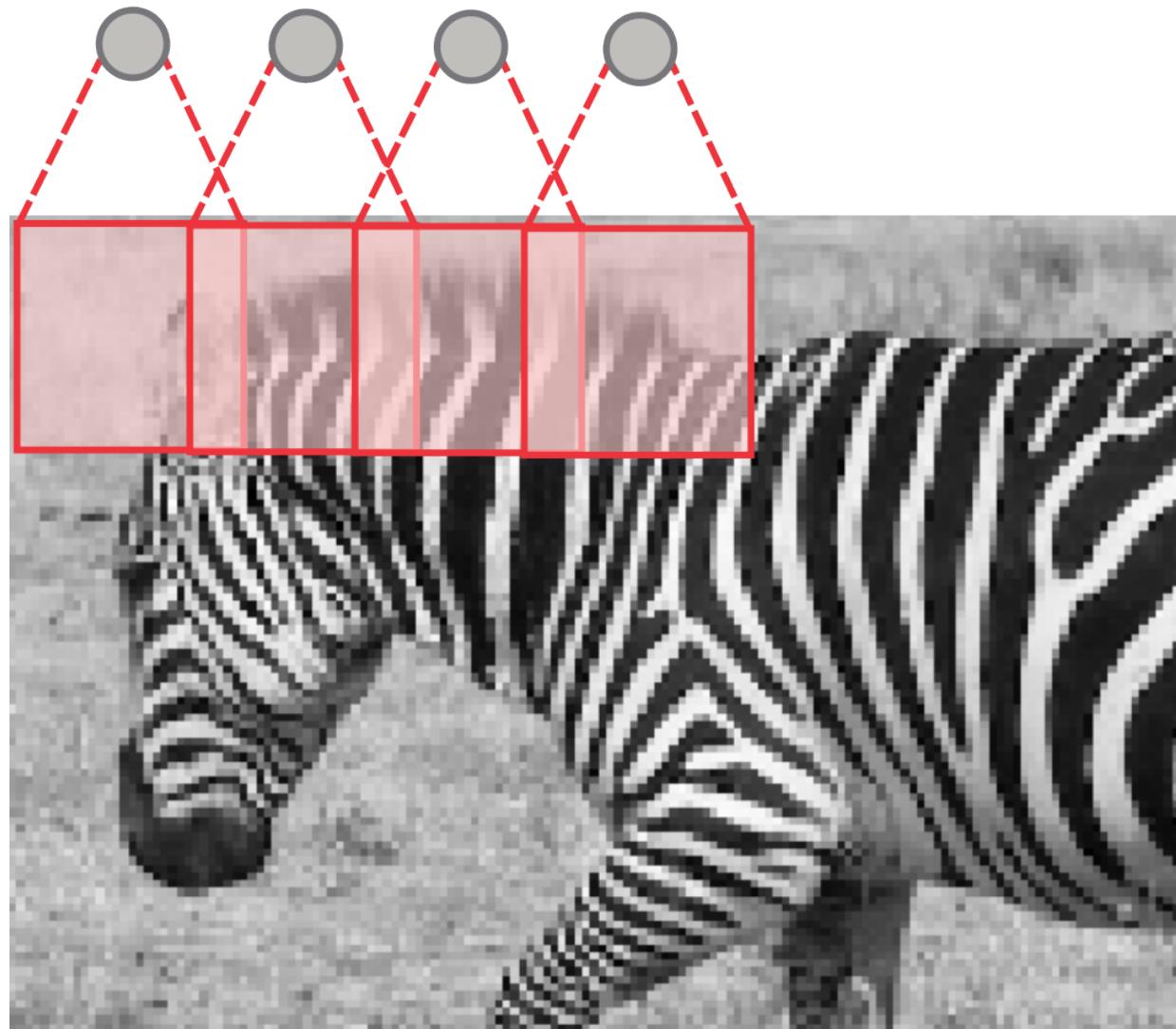


What are Gabor Filters?



- Gabor filters are a class of linear filters used for texture and edge analysis in image processing.
- They are based on the mathematical concept of a sinusoidal wave (sine or cosine) modulated by a Gaussian envelope.

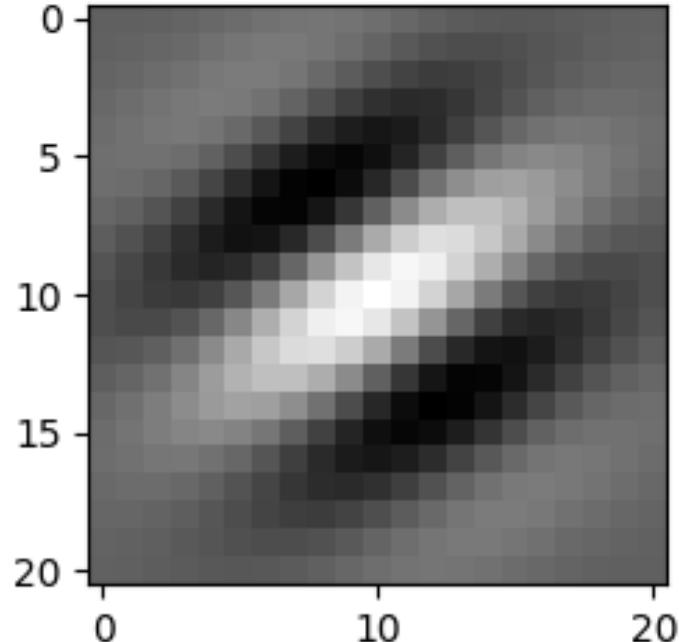
Neuron1 Neuron2 Neuron3 Neuron 4 ...



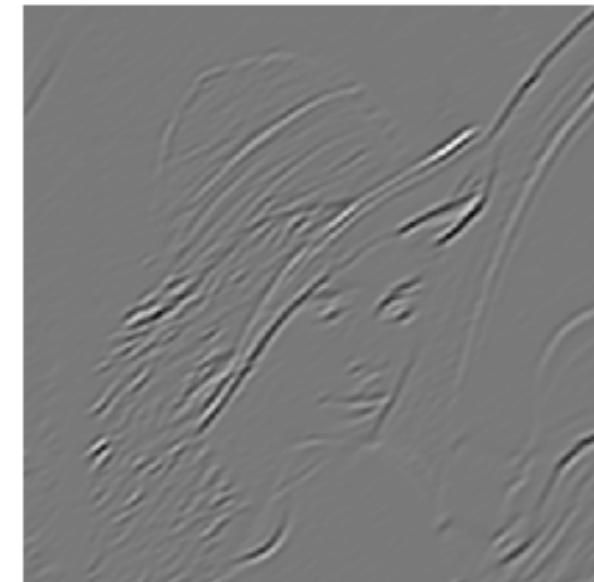
image



kernel



filtered



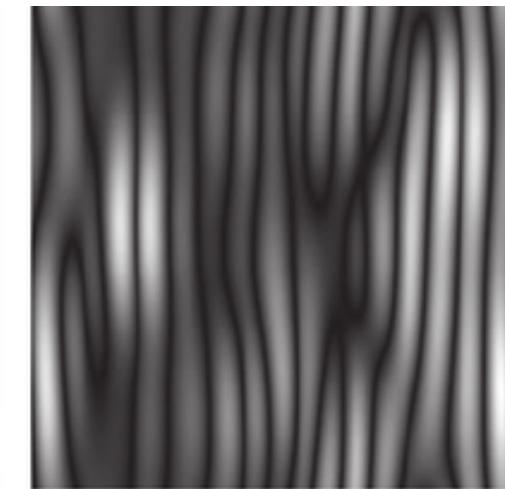
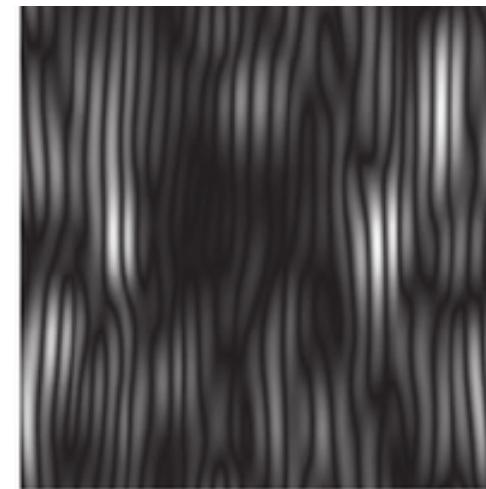
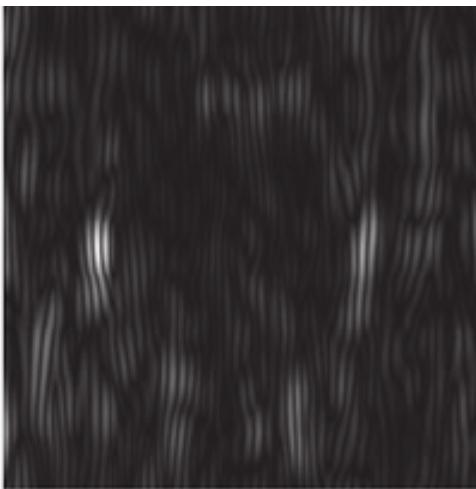
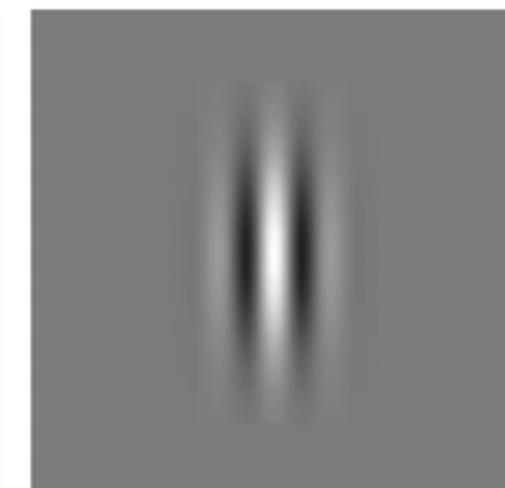


Image filtered with Gabor filters with different wavelength parameters:

Left to right: 16, 32 and 64.

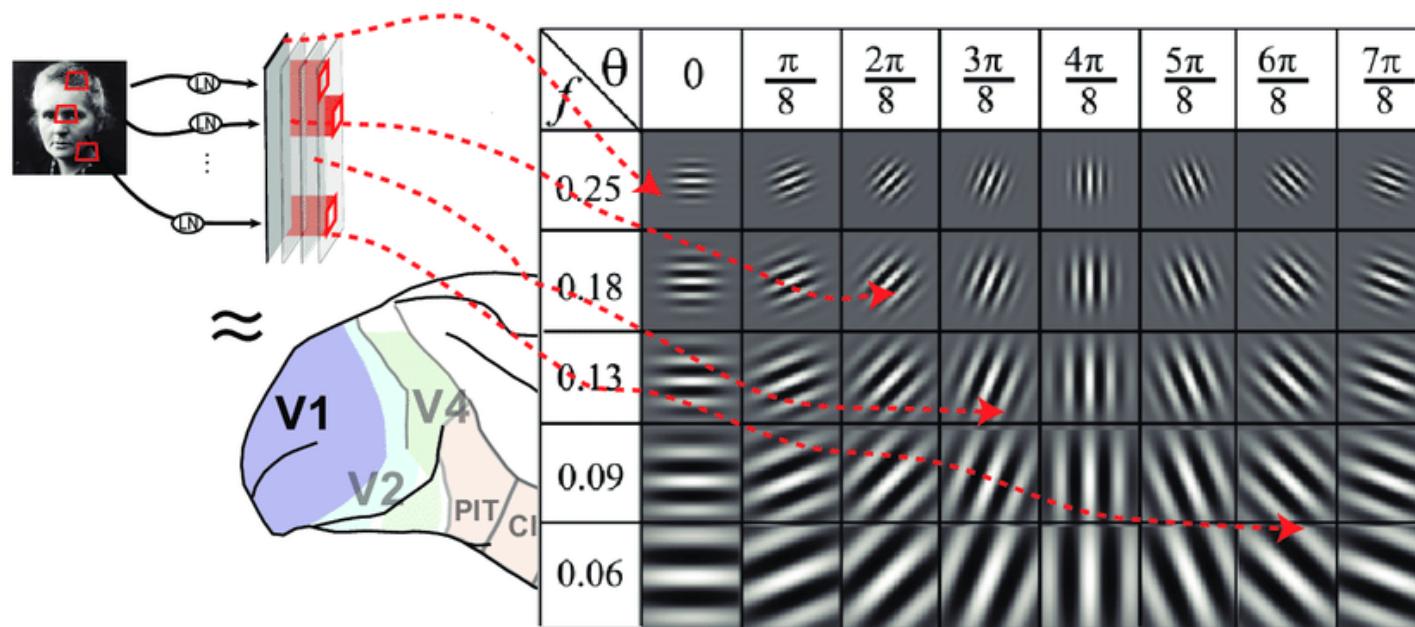
Top: Filtered results.

Bottom: Gabor filter.

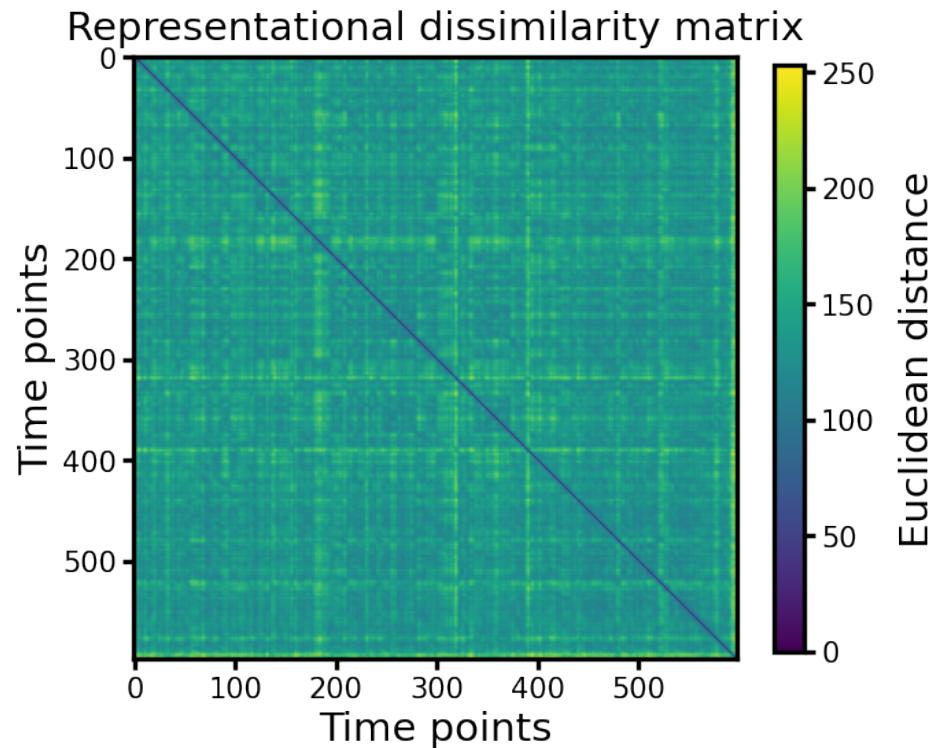


Role in Vision

- Gabor filters are thought to model the way the human visual system processes spatial and frequency information.
- They mimic the receptive fields of neurons in the visual cortex, particularly those involved in edge detection and spatial frequency analysis.



Representational Dissimilarity Matrices (RDMs)

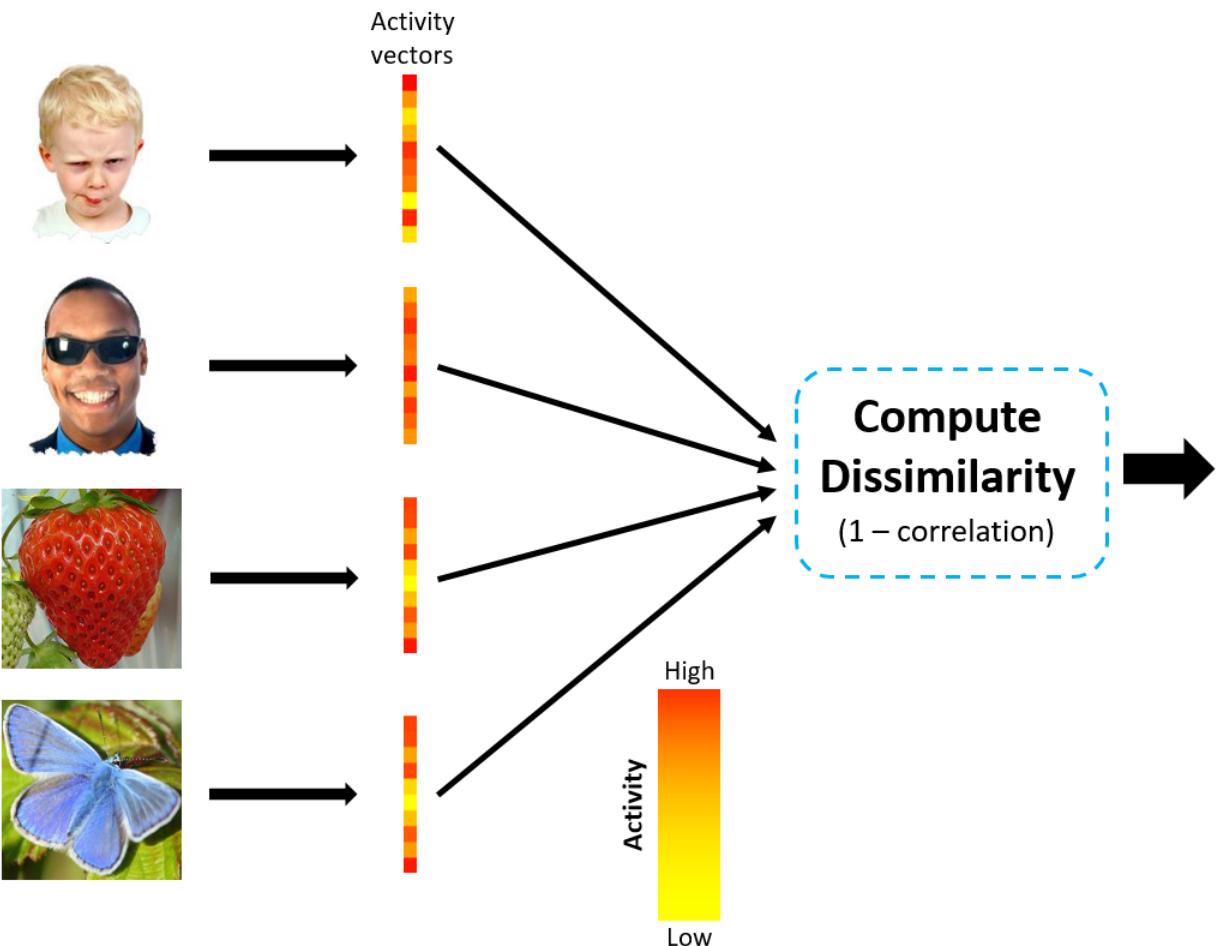


- Tools used to measure the dissimilarity between different representations of stimuli in a high-dimensional space.
- They capture the pairwise dissimilarities between different stimuli based on how they are represented in a given system (e.g., neural representations or computational models).
- RDMs are often used to compare the similarity between different brain regions or models when processing similar inputs.

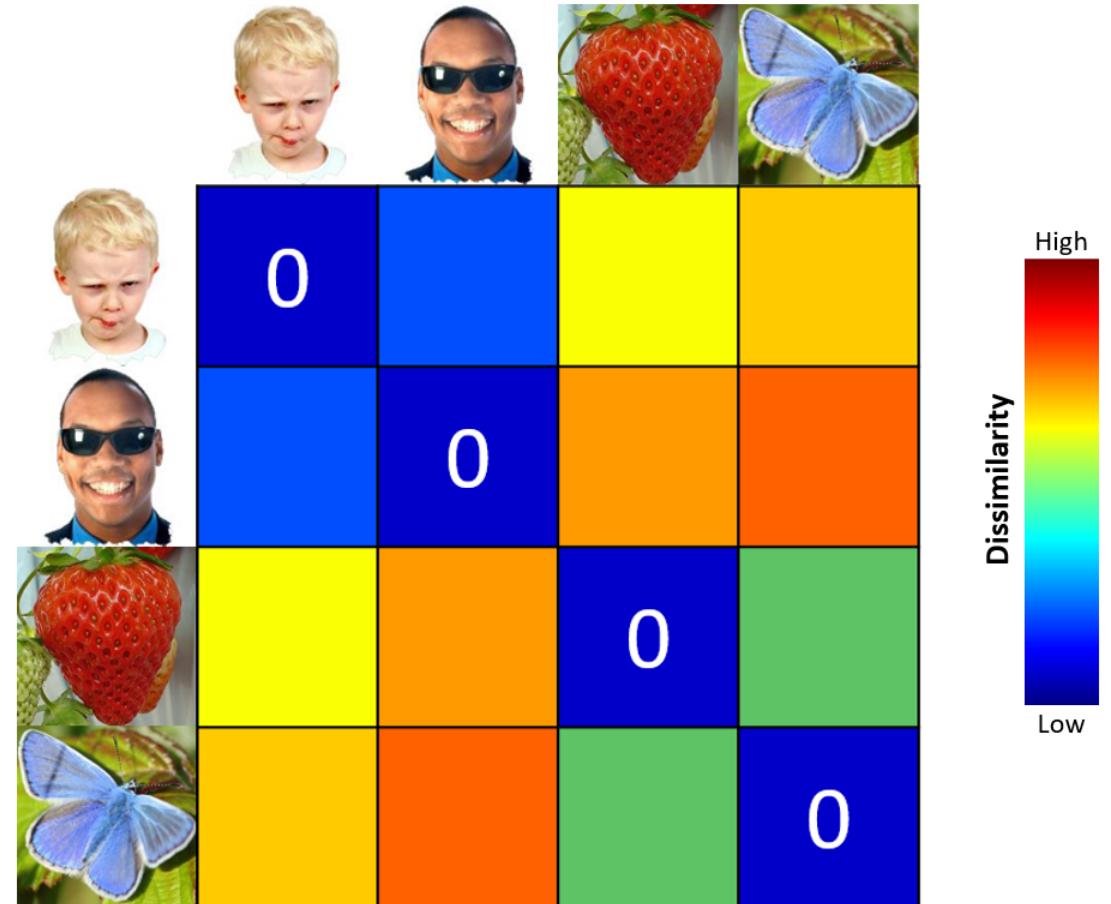
Representational Pattern

e.g. Activity from neurons, model units, or voxels recorded in vector format

Input Images
 $N = 4$



$N \times N$ Representational Dissimilarity Matrix (RDM)



Questions?