Hierarchical Visual processing and receptive fields (STAs and beyond)

AMATH 342

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eye

photoreceptor

bipolar cell

retinal ganglion cell

optic nerve
eye

retina

optic nerve

retinal ganglion cell

bipolar cell

photoreceptor
What is a “receptive” field?

- Particular region in sensory space that triggers the firing of a neuron
- Sensory space has an associated template which the cell responds to
- Exists for sensory modality like visual, auditory and somatosensory system
- Term coined by Sherrington to describe the area of a skin that elicits a scratch reflex in a dog
- Visual system => receptive field ------ visual space
OFF retinal ganglion cell receptive field

spikes
stimulus
time

OFF retinal ganglion cell receptive field

spikes
stimulus
time
OFF retinal ganglion cell receptive field

Retinal ganglion cell receptive fields

black & white on-center

black & white off-center

30%
Retinal ganglion cell receptive fields

- Green on-center
- Red on-center
- Blue on-center
- Black & white on-center
- Black & white off-center

30%
Retinal ganglion cell receptive fields

- green on-center (70%)
- green off-center
- red on-center
- red off-center
- blue on-center
- black & white on-center (30%)
- black & white off-center

Retina
LGN has similar receptive field structure as retinal ganglion cells

- **contralateral eye**
- **ipsilateral eye**

LGN

Area V1
Primary Visual Cortex
Earliest attempt to find the receptive field template of V1 cells

Hubel and Weisel V1 Video

https://www.youtube.com/watch?v=8VdfF3egwfg
Area V1 has two different kinds of cells based on their response properties.

- Simple cell
- Complex cell

Selective
Area V1 has two different kinds of cells based on their response properties

- Simple cell
- Complex cell

Selective
Invariant

Simple cell receptive field
How is receptive field structure of simple cell derived from LGN cells?
Many LGN cells project to a simple cell to form elongated receptive field structure
Many LGN cells project to a simple cell to form elongated receptive field structure

Adapted from Fig 21.1, Cox and Gabbiani
Interim Summary

- Receptive field – Part of the visual space which the neuron responds to
- Hierarchy in visual circuitry
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