Lecture 9

The eye

- Evolution is stupid: photoreceptors are pointing in the wrong direction
- Light passes through the ganglion cells, middle layer and bounces to the back of the eye
- Wavelength sensitivity of cones and rods
    - Rods: 495 nm
    - Cones
        - Red: 560 nm
        - Green: 530 nm
        - Blue: 430 nm

Both eyes project to both hemispheres

- Optic chiasm: Where information crosses to the other side
    - left visual field from left eye to the right side
    - right visual field from right eye to the left side

The Lateral Geniculate Nucleus of the thalamus is a key waystation for visual information

- The signals from each eye are segregated within the LGN and go into different ocular dominance columns within area V1, **layer 4**

Primary visual cortex contains a retinotopic map

- Half of the visual cortex is representing just the middle of the visual field

- The other half for the other parts of the visual field (periphery)
- Vision is best at the fovea

Gabor wavelets describe natural images

- Gabor functions more efficient than pixels

V1 neurons are tuned for orientation

- V1 neurons can be modeled as Gabor functions
- Visual system is optimized to process natural scenes

Human V1 can be modeled as motion-energy filters

- Roughly moving Gabor functions
- Simple cell neurons prefer static stimuli
- Other prefer moving stimuli
    - Speed
    - Direction
- Complex cells are composed of simple cells
    - These don't care about phase
- Predictions of the motion-energy model

Each voxel must represent many dimensions

- Features represented within area V1:
    - X position
    - Y position
    - Eye of origin
    - Wavelength

- Orientation

- Direction

- Spatial frequency: size

- …

Systematic changes across the hierarchy

- Dozens of distinct areas

- Areas arranged in a hierarchical, parallel network

- Transformations between areas are nonlinear

- Areas contain systematic, high-dimensional maps

- Each area represents different visual information

- Receptive field size increases by a factor of ~4 at each stage

- Across the visual hierarchy, neurons become selective for more complex image features, and combinations of image features

- Across the hierarchy responses become more invariant for incidental features of the image:
    - lighting
    - contrast
    - spatial position
    - retinal size
    - (possibly) viewpoint