Week 7

Synthesis Questions

Vision Anatomy and Physiology

- Where in the brain do signals from the retina go before reaching the visual cortex?
  - Thalamus
- Describe the phenomena of retinal neurons that "get tired". Do you think there are analogous processes in deep learning or convolutional neural networks?
  - Retinal neurons get tired after prolonged exposure to a particular visual stimulus, which makes them unresponsive to other stimuli.
  - The analogous process in DL and CNN would be overfitting. When a model is trained on a dataset with a specific stimulus, the model will become less responsive to other stimuli because it is fitted too well to the training dataset.

Primary Visual Cortex

- What wavelengths of light can humans detect? Why might we only be able to detect such a narrow band of light wavelengths? What would be an advantage and downside of processing more?
  - 400-700nm
  - Narrow band because of the limited sensitivity of our photoreceptors (rods and cones)
  - Advantage of more: can perceive more colors and spectrums of light
  - Disadvantage of more: need more processing power in the brain
- What is V1 in the visual cortex? What are those cells most sensitive to?
  - First stop for visual information (primary visual cortex in the occipital lobe). About 2mm thick and highly organized: contains cortical columns, organized retinotopically, shows cortical magnification
  - Contains simple, complex, and end-stopped cells.
  - Most sensitive to bars or edges with narrow ranges of orientations.
- What is the fovea best at detecting?
  - It is the best at detecting details as it is in the center of our focus.
- Describe the retinotopic nature of the visual cortex (7:58) in your own words. Hypothesize whether convolutional neural networks might be organized as "retinotopic".
  - The spatial mapping of features in retina is preserved in V1 where adjacent regions in the retina are also adjacent regions in V1.
  - Convolved data are kind of retinotopic because it preserves relative positions
- Describe cortical magnification and the causes of the trade-off between acuity and sensitivity. What are several reasons we can't see details from extremely far away, as for example, hawks can?

– Fixation point is magnified because the fovea has more photoreceptors and less convergence.
– Leads to better acuity, focused feature will have high acuity
– Tradeoff: better acuity at fovea, better sensitivity at periphery

Functional Areas, Pathways, and Modules

- Describe at least 5 functional parts of the visual system
  – V1: primary visual cortex, handles easy features like edges
  – V4: on the back of the brain, handles color perception and perceiving the curvature of edges
  – MT: small, in the center, handles motion perception
  – Lateral occipital cortex and IT cortex: recognize complex shapes
  – Intraparietal sulcus: handles visually guided action like grasping
- What is the "what" stream? What does it do?
  – Ventral pathway (the bottom): V1&V2 -> V4 -> Inferotemporal Cortex
  – Transfers information about objects' identity like color and shape
- What is the "where" stream? What does it do?
  – Dorsal pathway (over the top): V1&V2 -> MT -> Parietal Cortex
  – Transfers information about objects' motion and location, and guided action
- What is a region that processes faces? What inputs does it receive? What other regions is it near?
  – Fusiform face area within the inferotemporal (IT) cortex
  – Near the parahippocampal place area and IT cortex