

Assignment 3: The Visual System

Due: Monday, March 2, 11:59pm

Value: 15% of total marks for the course

The purpose of this assignment is to test your knowledge of the brain's visual system and the relationship between neurobiological features and computational properties. The best answers will discuss both function and anatomy, and will draw on specific anatomical examples to support theoretical claims. You are encouraged to discuss answers with your classmates, consult the slides notes, or use external resources -- but your answers must be your own! In particular, read the Kandel et al. chapters listed on the slides. Expect to write 2-5 sentences for each 1 point.

1. **[4 points]** Choose 4 feature detectors in the visual system, including at least one from each of (a) the retina, (b) areas V1-V4, and (c) inferior temporal cortex or parietal lobe. Describe how neural networks implement these feature detectors, discussing receptive fields, connectivity, and inputs/outputs as necessary. How do each of these features contribute to vision as a whole?
2. **[3 points]** Describe 3 instances in which retinotopic organization facilitates visual processing. For each example, be sure to both (a) mention its anatomical location and (b) discuss how retinotopy contributes to its feature detection.
3. **[2 points]** Discuss similarities and differences between convolutional neural networks and the visual system.
4. **[1 point]** Why is having two eyes important for vision? Could we get by with just one?
5. **[1 point]** What would be the effect of strengthening lateral connections between horizontal cells in the retina? What about strengthening lateral connections between orientation columns in V1?
6. **[1 point]** How do normalization and adaptation affect the perception of color and luminance?
7. **[1 point]** Briefly summarize the differences between the dorsal and ventral streams.
8. **[1 point]** Compare the behavioral deficits that result from lesions to inferior temporal cortex versus parietal cortex.
9. **[1 point]** Name a few ways in which prefrontal cortex and hippocampus aid visual processing in cognitive tasks.
10. **[Bonus: 0.5 points]** Why is it easier to see objects in your peripheral vision at night?
11. **[Bonus: 0.5 points]** What is the purpose of saccadic eye movements?