COMS30017 Computational Neuroscience Week

Week 1 Problem sheet

Video 1

- Name three ways that the operation of human-made computers differs from brains.
- How many neurons are in the human brain?
- What is the relationship between machine learning, deep learning, and computational neuroscience?
- What are the two main practical ways of doing computational neuroscience research?

Video 2

- Fill in the blanks: the brain comprises __% of human body weight but uses __% of the body's energy.
- What are the two key functions of the hippocampus?
- Parkinson's is due to cell death in which brain region?
- Which brain region contains most of the brain's neurons?
- Which brain region produces the neuromodulator dopamine?
- What does the "topographic" layout of the sensory and motor homunculi refer to?

Video 3

- Which tend to be longer, axons or dendrites?
- My favourite joke (for kids) is "Why do giraffes have long necks? ... To reach their heads!". In what way is this related to the anatomy of a single neuron?
- Which of axons vs dendrites carry input vs output signals to/from the soma?
- Which part of the neuron is primarily responsible for storing memories?

Video 4

- Roughly how many excitatory synaptic inputs would need to arrive simultaneously to cause the neuron to spike (compare the typical "post-synaptic potential" to the spiking threshold)?
- What is meant by a "synaptic weight"?
- What is the key non-linearity in the neuron's input-output function?
- Which is more computationally powerful: recurrent or feedforward neural networks? And why?

Video 5

- What is the minimum sampling rate we would need to record all the spikes of a neuron in the brain? What determines this rate?
- What do the terms "in vivo" and "in vitro" mean? And what are the relative advantages of recording in either way?
- What is the advantage of recording the intracellular voltage of a neuron compared with the extracellular field potential?
- What does fMRI measure? And why is it so slow?
- Can you think of any potential advantages of calcium imaging over electrophysiology for recording neural activity? (I didn't really mention them in lecture).