COGNITIVE NEUROSCIENCE FOR AI DEVELOPERS (SS 2023)
Week 04 - Neural Plasticity

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Single Choice Exercise // Only one answer is correct

Q1: Neural plasticity does not include

A. Synaptic plasticity
B. Brain growth
C. Reorganization
D. Structural plasticity
E. Apoptosis

Q2: Which of the following statements applies to Hebb's rule?

A. It is a simplified form of the Delta rule
B. It is a supervised learning paradigm
C. Hebb's rule only allows LTP
D. Neurons that fire together, inspire together
E. Hebb expanded the BCM rule

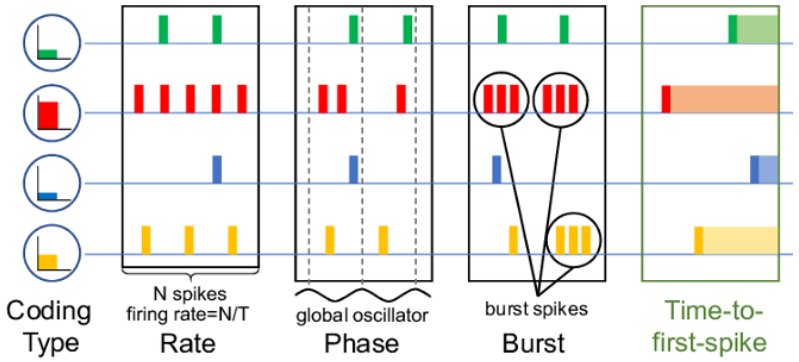
Q3: What of the following algorithm optimizes artificial neural network architectures?

A. Canny Edge Detector
B. Neuroevolution of Augmented Topologies
C. Oja's rule
D. Spike-timing-dependent plasticity
E. PCA

Q4: Which of the statements w.r.t. Hodgkin-Huxley (HH) models is CORRECT?

A. They do not need Kirchhoff's law
B. They can be barely explained by biophysical properties of neurons
C. They rely on three dynamic variables: n, m and h
D. The variables alpha and beta are solved using sigmoid integrations
E. Spiking frequency is not dependent on input current

Neural codes are essential for information processing in neurons:



Task: Talk to a colleague and identify what patterns exist (e.g. using the figure above) and what maybe reasons to use different neural coding strategies.

The paper by Axel Borst and Frédéric Theunessen is a major paper that discusses neural coding and information theory. Here is the paper abstract:

Information theory quantifies how much information a neural response carries about the stimulus. This can be compared to the information transferred in particular models of the stimulus–response function and to maximum possible information transfer. Such comparisons are crucial because they validate assumptions present in any neurophysiological analysis. Here we review information-theory basics before demonstrating its use in neural coding. We show how to use information theory to validate simple stimulus–response models of neural coding of dynamic stimuli. Because these models require specification of spike timing precision, they can reveal which time scales contain information in neural coding. This approach shows that dynamic stimuli can be encoded efficiently by single neurons and that each spike contributes to information transmission. We argue, however, that the data obtained so far do not suggest a temporal code, in which the placement of spikes relative to each other yields additional information.
(link to paper: https://www.nature.com/articles/nn1199_947)

Please answer the following questions:
Q1: What is temporal code?
Q2: What would we understand w.r.t. Stimulus-response function?
Q3: How can we quantify how much information a neural response carries w.r.t. A given stimulus?