7:00 - 7:30   (A1) Neural mechanisms of the birdsong syntax
                Alexay Kozhevnikov (Pennsylvania State University), and Dezhe Jin

Mitral/tufted cells of the olfactory bulb receive odorant information from receptor neurons and transmit this information to the cortex. The most abundant cell type in the olfactory bulb is the population of inhibitory interneurons called granule cells that form unusual dendrodendritic synapses with the mitral cells. Granule cells is continuously generated throughout the lifetime of the organism by the population of progenitor/stem cells located in the subventricular zone. Despite these complex processes, granule cells do not project out of the olfactory bulb. Here we propose that granule cells form sparse incomplete representation of olfactory stimuli. The errors of these representations are transmitted to the olfactory cortex by the principal neurons of the olfactory bulb. We explore the possible mechanisms of learning by the granule cells and compare these results with experimental data.

7:30 - 8:00   (A2) Completing and testing biophysical models in neurobiology
                Henry Abarbanel (UC, San Diego)

We have developed a complete statistical formulation of the transmission of information from experiments in neurobiological preparations to detailed biophysical models of the individual neurons or networks observed. We will discuss the general framework as well as useful, practical implementations for quantitative characterization of the measurements. Using several Hodgkin-Huxley models we will illustrate procedures for developing, completing, and testing models of observations. Then in connection with the linked presentation (Margoliash), we will discuss how these approaches work in practice in an analysis of results for single neurons recorded in brain slice preparations in the sensorimotor nucleus HVC of the zebra finch song production pathway.

8:00 - 8:30   (A3) Adding biological realism to HVC network models
                Daniel Margoliash (University of Chicago), and Henry Abarbanel

Currently there exist two complementary approaches to modeling neuronal networks. One takes general features of neurons and circuitry (e.g. assumptions regarding the canonical neocortical circuit) and uses those to compute generic physiological characteristics. A second involves more traditional biological approaches including extracellular and intracellular recordings to build up detailed descriptions of classes of neurons. Each can inform the other, but combining information from the two approaches has been challenging. We are developing techniques that can characterize the activity of individual neurons in terms of a Hodgkin-Huxley like formulation, including estimation of parameters and states of the voltage-dependent currents. Our goal is to characterize the different classes of HVC neurons in the zebra finch song system, including variation across individual birds, and build networks of these neurons constrained by known connectivity, and examine the activity of these networks in relation to the known HVC physiology. In the first part of the talk, I will describe why HVC is a good target for these efforts. In the second part of the talk, I will describe results from modeling some classes of HVC neurons under conditions of whole cell recordings in slice preparations. The linked presentation (Abarbanel) will describe in detail the modeling methodology.

8:30 - 9:00   (A4) Maps and meters: Signal transformations for reconciling auditory and
                visual spatial information
                Jennifer Groh (Duke University), and Jungah Lee

The brain detects visual and auditory spatial information differently. The optics of the eye produce an image of the visual scene on the retina. This spatial code for stimulus location is preserved at subsequent stages of the visual system, with neurons exhibiting receptive fields and a retinotopic organization through at least the first several stages of cortical processing. In contrast, the auditory system has to construct an estimate of sound location based on interaural timing and level differences as well as spectral cues. These cues do not intrinsically provide for either receptive fields or maps of auditory space.

In previous work (Groh et al., 2003; Werner-Reiss and Groh, 2008), we have shown that the primate IC and auditory cortex appear to use a "meter"-like code for sound location: neurons do not exhibit circumscribed receptive fields tiling space, but rather exhibit activity patterns that are proportional to the eccentricity of the sound. Larger responses tend to occur for more contralateral locations, suggesting that the level, rather than the locus, of activity could be used to represent the location of sounds.

In the superior colliculus (SC), visual and auditory signals converge onto a common population of neurons responsible for guiding saccadic eye movements. We have investigated the nature of the auditory code for space in the primate SC, and we find that neurons continue to employ a meter-like code for sound, despite forming a map for visual stimuli.

This poses a conundrum because it means that the same neurons respond differently to targets of different modalities at the same location in space. Furthermore, if these neurons are to guide eye movements to that location, such differences must somehow be removed via the read-out mechanism that converts SC activity into a motor command. We propose a read-out model that can accomplish this task based on a combination of the locus and level of activity in the population of SC neurons.

We also suggest that the reason this meter-like code of auditory space may be employed is to facilitate the transformation of auditory signals from head- to eye-centered coordinates (Lee and Groh, 2012). In species with mobile eyes, such a coordinate transformation is required before visual and auditory information can be reconciled. This coordinate transformation can occur more efficiently in a meter-code domain than in a map-code domain. The ability to make eye movements may therefore dictate differences in auditory coding in primates compared to species with immobile eyes such as barn owls.

Groh JM, Kelly KA, Underhill AM (2003) A monotonic code for sound azimuth in primate inferior
        colliculus. Journal of Cognitive Neuroscience 15:1217-1231.
Lee J, Groh JM (2012) Auditory signals evolve from hybrid- to eye-centered coordinates in the
        primate superior colliculus. J Neurophysiol.
Werner-Reiss U, Groh JM (2008) A rate code for sound azimuth in monkey auditory cortex:
        implications for human neuroimaging studies. J Neurosci 28:3747-3758.