Spring 2009 Seminar Series

Department of Biomedical Engineering

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Odor processing in a biological and artificial olfactory system

How does the sensory system convert sensory stimuli into neural representations? In insects, odorants are detected by a large population of olfactory receptor neurons in the antenna, which convert chemical stimuli into an electrical signal that is relayed downstream for further processing in the antennal lobe (analogous to olfactory bulb in vertebrates). In the antennal lobe, interactions between ensembles of excitatory projection neurons and inhibitory local neurons reshape the receptor neuron input into complex, spatiotemporal patterns that are superimposed on a faster oscillatory field potential activity. The processed odor code is then transmitted to the mushroom body (analogous to olfactory cortex in vertebrates), a structure associated with olfactory learning and memory. In the mushroom body, odor representations are sparsened to facilitate storage and for association with other sensory modalities.

In this talk, I will explain how a complex pattern recognition task (olfaction) is performed in a relatively simple biological system. Electrophysiological recordings made in the locust will be presented to characterize the odor representations in the first three olfactory processing centers: antenna, antennal lobe and mushroom body. This talk will also include well-constrained computational models of the olfactory circuits to demonstrate the transformations that occur as information is transmitted from one circuit to the next, and to clarify their contributions to the odor encoding process.

In conclusion, I will summarize the olfactory design and computational principles and briefly discuss their application in developing a neuromorphic ‘electronic nose’.