

Learning classification and association in the olfactory system of insects

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We investigate the mechanisms of odor classification and association in the olfactory system of insects. The task of odor classification has several different aspects. On the one hand some similar odor receptions need to be classified as the same odor whereas on the other hand distinct odors have to be discriminated from each other. In addition some quite different odors might have the same *meaning* and therefore need to be *associated* with each other.

How does the olfactory system accomplish these quite different tasks with the available natural *technology*?

There are three known stages of neural processing of odor information before classification: *Data collection* from the sensors in the antenna, *information compression* and *temporal decorrelation* by the Antennal Lobe (AL), and *nonlinear projection/expansion* to the Kenyon cells (KC) of the Mushroom Body (MB).

Our main working hypothesis is that the first relay stations in olfactory information processing create a large coding space in which the representations of different classes of odors are spread out to allow easy (linear) discrimination in later stages. This strategy is called a support vector machine (SVM) in computer science. We propose a theory of odor classification that relies on this strategy and requires sparse coding, random connectivity, Hebbian learning and mutual inhibition. These ingredients turn out to be sufficient to allow efficient classification. Sophisticated global learning algorithms or a sophisticated network topology are not required.

Complementing the oral presentation of R. Huerta we elaborate on these concepts of odor classification on this poster and present a computer model implementing them in a framework of integrate-and-fire type neurons. The model is built with a size and connectivity inspired by the observed morphology of *drosophila*.

We are able to show that the mechanisms developed earlier in the digital framework of McCulloch-Pitts neurons carry over to the more realistic computer model essentially unaltered. The exceptions to this rule are found in the details of the Hebbian learning and the type of mutual inhibition employed. These specific properties are discussed in detail.