This is revised from the previous version. This is the correct abstract.

How to Design an Antennal Lobe: Exploration of digital local circuits for input decorrelation.

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The insect antennal lobe (AL) is the site of direct olfactory afferent input to and interactions between sets of excitatory projection neurons (PNs) and inhibitory local neurons (LNs). Chemically similar odors activate similar subsets of PN neurons. Recent evidence from fish (Friedrich and Laurent, 2001) supports the notion that the olfactory bulb, the vertebrate analog of the antennal lobe, acts as an encoder by decorrelating similar patterns of activation over time. The resulting decorrelated odor representations might make it easier for postsynaptic neurons to read out and classify odor information. Here we study the behavior of AL dynamics using a network of interconnected McCullough-Pitts units. The simplified model allows us to predict both analytically and via MonteCarlo simulations many properties of the system, including the mean firing rate, the divergence rate of similar patterns of activation in the system, and the stability of various parameter regimes. The analytic solution allows us to design our own networks by specifying a small subset of parameters and assessing stable regions within the remaining parameter space. For example, by specifying the number of neurons and the mean activity rate one can predict the connectivity and the rate of divergence for the network. We also explore the effects of various Hebbian learning algorithms on the network, which allow for the stability of odor trajectories by making them invariant to noise.