OSCILLATION *AND* CODING IN A FORMAL NEURAL NETWORK CONSIDERED AS A GUIDE FOR PLAUSIBLE SIMULATIONS OF THE INSECT OLFACTORY SYSTEM

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For the analysis of coding mechanisms in the insect olfactory system, a fully connected network of synchronously updated neurons (McCulloch-Pitts type or MCP) was developed (Quenet and Horn, 2003). Using an internal clock, this "Dynamic Neural Filter" (DNF) produces spatiotemporal patterns identical to synchronized activities recorded from the Projection Neurons (PN) in the locust antennal lobe (AL) in response to different odors. As an additional step, we separate the populations of PN and local inhibitory neurons (LN) in the DNF which remains a guide, as done in a previous work (Quenet et al, 2005) for simulations based on biological plausible neurons (Hodgkin-Huxley type or H-H). We show that a parsimonious network of 10 H-H neurons generates action potentials with a spatio-temporal pattern corresponding to the olfactory codes at the antennal lobe level. Taking advantage of the possible analytical description of the dynamical behaviour of networks of MCP neurones, we study the effects of considering two different populations of neurones, excitatory and inhibitory, on both coding *and* on oscillatory properties.

In order to further improve the biological plausibility of the MCP neural network we construct a more complex recurrent network. Our aim is to characterize the population dynamics for different values of the delays, connectivity and inputs. We explore both the effects of the *proportion of internal inhibition and excitation*, and those of the *proportion of external excitation to the internal one* on the behaviours the network exhibits. These effects can be compared to the ones that have been demonstrated in networks of integrate and fire neurones (Brunel, 2000). In addition, different levels of noise are examined and lead to transitions from synchronous to asynchronous firing modes.

We find a set of parameters which leads to *both the emergence of robust oscillations and spatio-temporal patterns* showing that PNs' activity is phase-locked to different cycles of the oscillations similar to the local field potential (LFP), and change with inputs.

We show that it is possible to introduce in the formal model of discrete time neurons additional biological constraints provided by experimental data describing the functional relationships between neuron types in the olfactory system. The pertinent structure of the formal network (delays, connection matrix and input vector) can be used then for more realistic simulations with continuous time neurons.

References :

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