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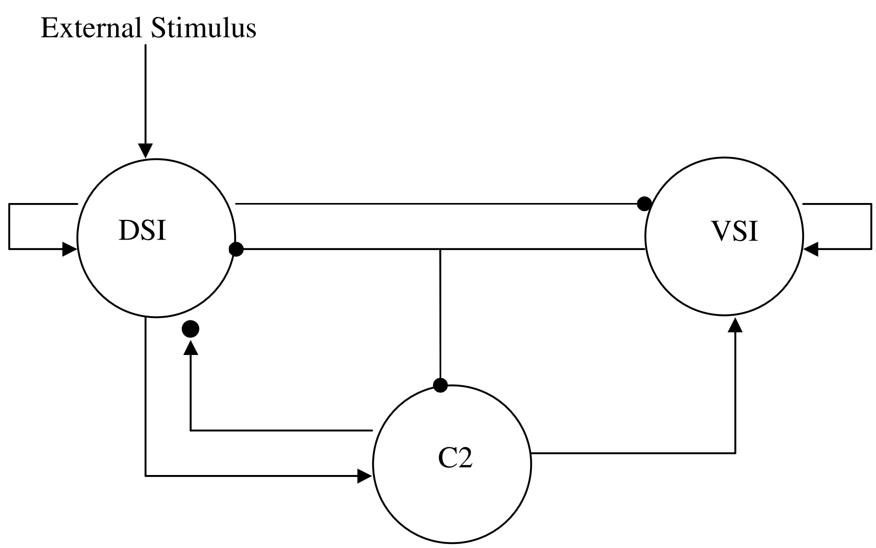
SIMPLE NEURAL NETWORKS

The small nervous system of invertebrates have been used extensively to study the cellular and synaptic basis for neural network organization. In this section we shall study, on a model basis, a ganglion of the mollusc *Tritonia diomedea*, to explain its escape swimming response. When touched by one of its tube feet Tritonia escapes by making a series of 2-20 alternating dorsal and ventral flection movements. The alternating burst pattern underlying the swim is produced by a central pattern generator (CPG) network consisting of at least 14 interneurons, each of which synapses directly onto motor neurons to form the final motor output pattern. The interneurons of the CPG can be grouped into three classes, called dorsal swim interneurons (DSI), ventral swim interneurons (VSI), and cerebral cell (C2). Activity, i.e. AP production, in the DSI causes contraction of the dorsal fins. Activity in the VSI causes contraction of the ventral fins. C2 is the integrating interneuron which interacts with the DSI and the VSI.

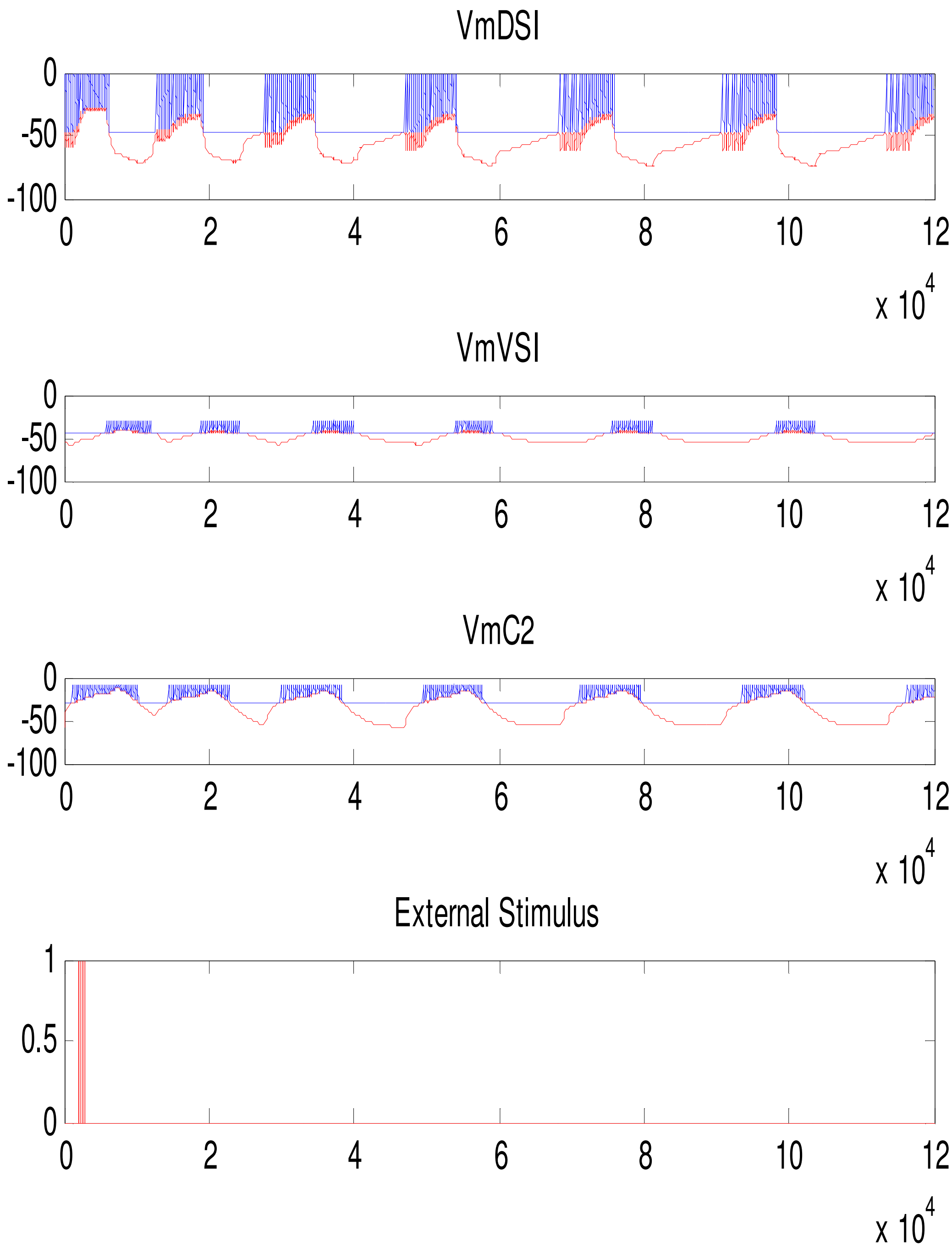
The pattern of synaptic connectivity between the classes can be shown by a “ball-and-stick” diagram as follows:



Here each circle represents a neuron class used in the model as a single neuron. The neurons are modeled using equations similar to the H-H equations however with modifications to decrease the computational cost of the simulations. The arrow and ball endings represent excitatory and inhibitory synaptic connections respectively. The synaptic input from C2 to DSI has early excitatory and late inhibitory effect.

In the following figure we have the membrane potentials of the DSI, VSI, adn C2 neurons where external stimulus is applied from 2000 to 3000 milliseconds. Spikes represent APs. We observe that there are alternating bursts from DSI and VSI indicating alternating movements of the dorsal and ventral fins. The repetition frequency decreases by time and finally the system, and hence the Tritonia, stops.

This simple network example shows us that many of the behaviours of even higher animals are manifestations of neural networks which are arranged in complex feedback configurations.


VmDSI
0
-50
-100
0
2
4
6
8
10
12
x 10^4
VmVSI
0
-50
-100
0
2
4
6
8
10
12
x 10^4
VmC2
0
-50
-100
0
2
4
6
8
10
12
x 10^4
External Stimulus
1
0.5
0
0
2
4
6
8
10
12
x 10^4