Artificial grammar recognition using two spiking neural networks

Philip Cavaco[1*], Baran Curuklu[1] and Magnus Karl-Petersson[2]

- [1] Malardalen University, IDT, Sweden
- [2] F.C. Donders Centre for Cognitive Neuroimaging, Netherlands

Introduction:A biologically inspired neocortical model consisting of spiking neurons is designed to perform artificial grammar processing. Building on work in [1] the model is designed to categorize symbol strings as belonging to a Reber grammar [2]. Columnar organization of the cortex is used as the general inspiration of the network [3,4].

Each node is a minicolumn model consisting of 100 neurons; of which 80 are excitatory and 20 inhibitory. Excitatory connections inside the node sustain activity. The nodes are designed to sustain the activity for 1000 ms after the node received input. After that time local inhibition overcomes excitatory activity silencing the node.

Two network topologies were compared in this project. One consists of a complete set of nodes representing every bi-gram and tri-gram producible by the grammar. The nodes are configured in a hierarchy with the substring length increasing by one symbol with higher levels. Feed forward connections are used to propagate activity between layers. The other network consists of a minimized number of nodes which represent states in the finite state machine (FSM) defining the grammar. This, minimized network, maintains a higher level of activity but performs comparably to the complete network. In this network nodes are re-used to represent multiple substrings.
The minimized network demonstrates the spiking neural networks ability to store and extract complex information with a small number of nodes.

Discussion: The performance of the two networks investigated here supports the feasibility of artificial grammar recognition using spiking neural networks. Future work will benefit from collaboration with experimentation of the same recognition task in clinical trials.

References

1. Petersson KM et al.: Artificial grammar learning and neural networks. Proc. Cogn. Sci. Soc. 2005, pp. 1726-1731.

2. Reber, AS: Implicit learning of artificial grammar. J. Verb. Learn. & Verb. Behav. 1967, 6, 855-863.

3. Ã‡Ã¼rÃ¼klÃ¼ B: A Canonical Model of the Primary Visual Cortex. MÃ¤lardalen University Press, 2005

4. Mountcastle VB: The columnar organization of the neocortex. Brain 1997, :701-722.

5. Gewaltig MO and Diesmann M: NEST. Scholarpedia 2007, 2(4):1430