Robust Cortical Learning

Goals: Explore the potential of "cortical learning" to tolerate failures and asynchrony of communication.

Tools: Logic, algorithmic reasoning, programming

Prerequisites: basic knowledge of distributed algorithms and neural computation, basic concurrent programming skills, curiosity and persistence

Summary

The goal of this interdisciplinary project is to explore computational mechanisms of learning in the brain. In the conventional *neuronal* model [3], the cortex is represented as a large random graph of *neuroids* (abstract neuron-like automata) connected via directed edges called *synapses*. Communication between neuroids is bound to be *vicinal*: a neuroid *fires* if the sum of potentials of all firing neuroids with synapses to it exceed a specific theshold. In this model, the problem *unsupervised learning* consists in memorizing an *input pattern* $x \in \{0,1\}^n$, i.e., associating x with a hierarchical structure in the cortex and a top-level pattern $I(x)$ so that (1) for all $x \neq y$, $I(x) \neq I(y)$ and (2) whenever x fires, $I(x)$ fires too.

It has been argued that learning can be implemented with simple primitives [1, 2, 4], such asLINK, JOIN and PJOIN. For example, if two items A and B are already represented in the neural system, the primitive JOIN(A, B) modifies its structure so that a new item C will fire whenever representations of A and B fire. This way massively distributed cortical computation can be viewed as a composition of simple sequential primitives, which can be implemented in the vicinal way.

This project intends to extend this approach to *fault-prone* in which neuroids or synapses are subject to failures, which may affect the process of learning. Pursuing this goal may require reconsidering existing models of cortical computations and deriving new algorithms for *robust* (fault-tolerant) learning.

Contact

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