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A Learning Rule System for a Simple Model of Anticipation in Cortex

Ralf Möller, Horst-Michael Groß

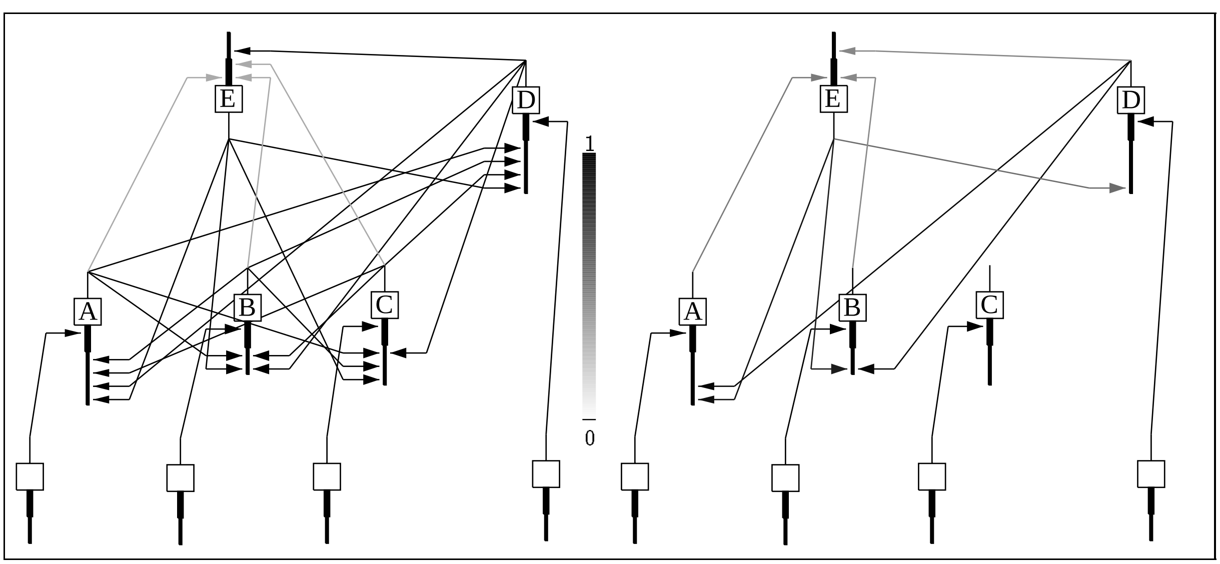
Technical University of Ilmenau. Department of Neuroinformatics.
98684 Ilmenau / FR Germany.

A model of visual perception has been developed in our group, which tries to avoid the artificial separation between units for recognition and units for generation of behaviour [1]. A 'level of representation' usually introduced between both parts is not suitable to explain recognition ability because in this level, sensory information is represented only in a *reencoded form* — one has to introduce an internal observer, who generates the behaviour looking at this information. In contrast our model considers perception to be an *internal simulation of actions and the anticipation of their consequences in the given situation* performed in the associative parts of the cerebral cortex.

Anticipatory hypotheses can be generated only if knowledge about relations between sensory channels and motor commands has been self-organized in an internal model before. The learning rule system developed for this purpose is based on the detection of coincidences between those signals; the coincidences are reflected in synaptic weights of a *coincidence pathway* between neurons. Complex signals (conjunctions of signals) are represented in weights of a *conjunction pathway* only if they are of importance for the anticipation process, i.e., if they take part in coincidences.

There is no separate learning and recall phase in our model. Input information and anticipatory hypotheses are distinguished using separate activity ranges; learning is restricted to high 'input' activity. The separation of activity ranges is maintained throughout all processing levels by the two types of pathways between neurons.

The figure shows the initial and final simulation state of a simple network composed of spiking neurons. The input neurons in the lower part are activated randomly, superimposed with a coincidence between the conjunction $A \wedge B$ and channel D. E specializes to represent $A \wedge B$ in the conjunction path (supposed to be the proximal part of the dendrite in a first hypothesis, thick bar in the figure), because $A \wedge B$ is coincident with D, which in turn leads to symmetric high weights in the coincidence path (distal dendrite, thin bar in the figure) between E and D. A *pre–not–post* coincidence learning rule was used to set up asymmetric weights between two neurons, like between B and D in the figure. (Weights below 0.2 skipped in the figure.)



[1] Möller, R.; Groß, H.-M.: in Proceedings of ICANN'93, 67–70, Springer 1993