BLISS: Towards the Simulation of Brain-Like Systems

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The Brain-Like Systems Simulator (BLISS) is a novel framework for simulating large, structured networks of biologically realistic neurons. It is based on the simulation system SYNOD [1] and uses an object oriented approach (see also [1,2]). The biological system to be simulated is broken down into basic components (e.g. neurons, synapses) whose prototypes are then represented by so-called *classes* as part of a class hierarchy. A common *base class* at the root of the hierarchy defines the set of core properties which apply to all network elements. We aim at networks with more than 10^4 neurons.

Our approach differs from existing solutions in the way neurons and networks are represented. Structural model concepts like micro-circuits, columns, and areas can be directly mapped to the simulated network. Networks are regarded as hierarchical structures. Thus, network nodes are either neuronal elements or sub-networks which may again be composed of neuronal elements or sub-networks. Each network element is assigned an *address* which uniquely specifies the element's position within the network structure. Thus, coordinate systems of arbitrary dimensions can be defined.

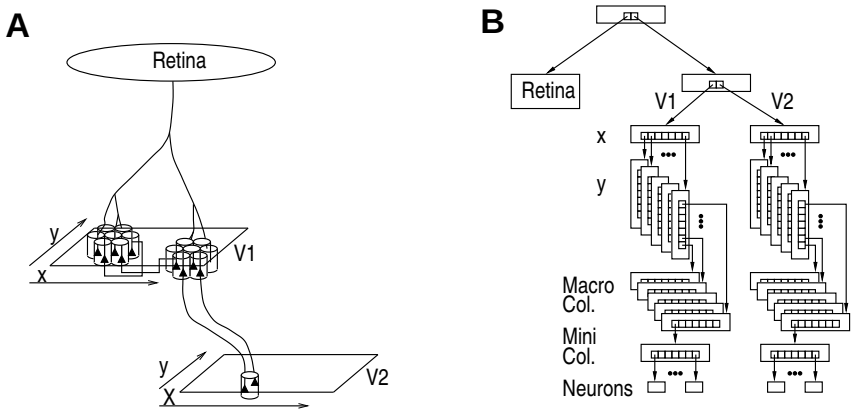

Fig. A shows an example of such a hierarchically structured model (see e.g. [3]). The retina sends input to a first visual area V1 which consists of topographically organized macro-columns. These, in turn, consist of orientation columns. Finally, orientation columns consist of model neurons. Other areas like V2 have a similar structure. Fig. B shows how the model may be represented in the framework presented here. The tree reflects the semantic structure of the model rather than the connectivity of the net. The *retina* models a large set of neurons in terms of a single object. Sub-networks group other elements, thereby defining coordinate systems, columns, macrocolumns, and areas. Note that atomic network elements can differ considerably in complexity. They are represented by separate objects as *leafs* of the network tree. Examples are the individual neurons of V1 and V2, or the retina model. Not shown in this example are the objects which are used to manipulate and observe the simulated system. These are also part of the model and are represented by *devices* which are motivated by the various measurement and stimulation devices, commonly found in electro-physiological experiments. The system is currently being used to investigate a model of the primate ventral visual pathway [3].

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[1] Diesmann M et al. (1995) in Menzel R & Elsner N (Eds) Göttingen Neurobiol Rep vol 2 p 552
[2] Goddard N et al. (2000) to appear in Bower J et al (Eds) Comp Neurosci: Trends in Research 2000
[3] Körner E et al. (1999) Neural Networks 12 (7–8):989–1005