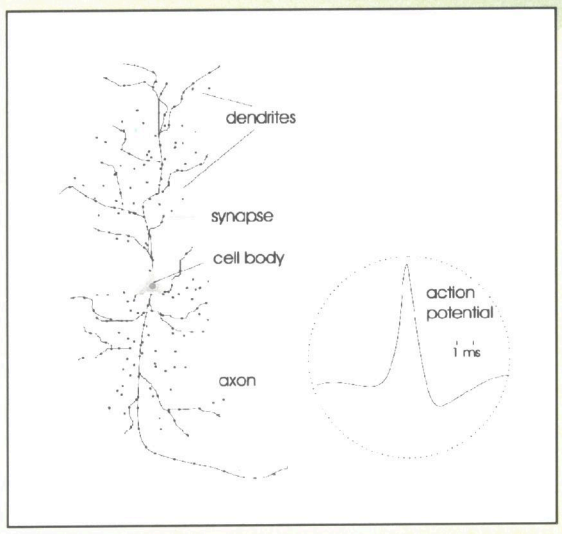
ARCHIEF BIBLIOTHEEK CWI - 19-21

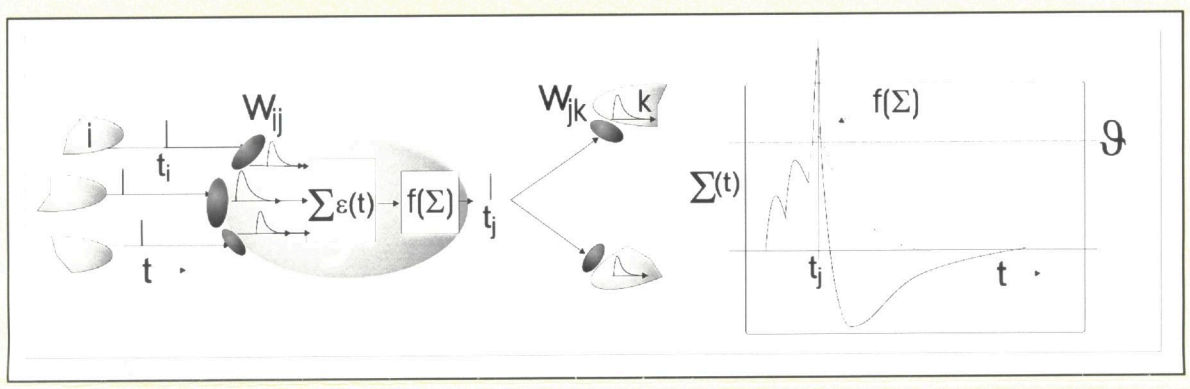
Centrum voor Wiskunde en Informatica

Asynchronous Spiking Neural Networks



A detailed view of a biological neuron: input spikes from other neurons are received via the dendritic tree. Spikes are transmitted to other neurons through the axonic tree. Connections between neuron occur at synapses, where arriving action-potentials, or spikes, affect the state (potential) of the target neuron.

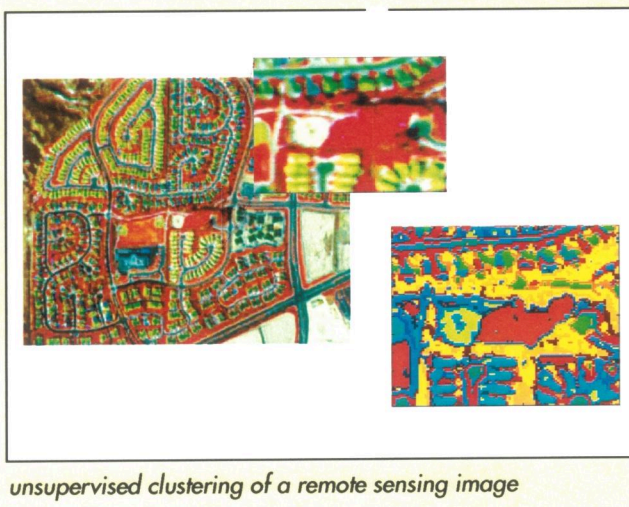
- New type of neural network that computes with single action potentials (spikes): a neuron computes the timing of its output spikes as a function of the timings of its input spikes.
- Theoretically, such spiking neural networks are computationally more powerful than traditional neural networks.
- Research is aimed at "unlocking" this computational power for advanced learning applications.



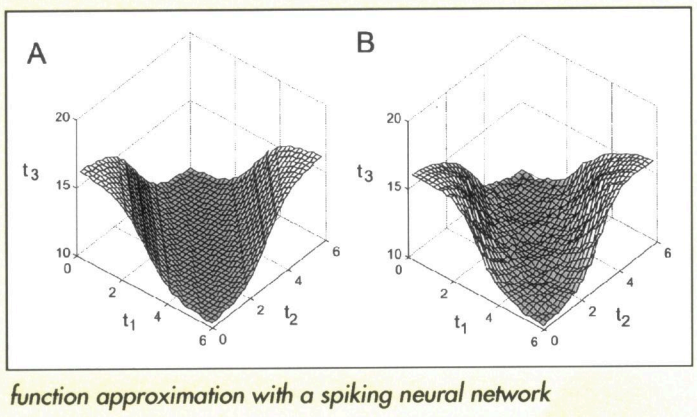
Computing with spike times: in a spiking neuron, input spikes affect the state of the neuron. If this state reaches a threshold, the neuron produces a spike itself. For precisely times input spikes, the timing of the output spike can be considered the neural computation.

Results

- Research has shown that Asynchronous Spiking Neural Networks can perform traditional tasks like Unsupervised Clustering and Supervised Learning via error-backpropagation, at least equally well as traditional neural networks.

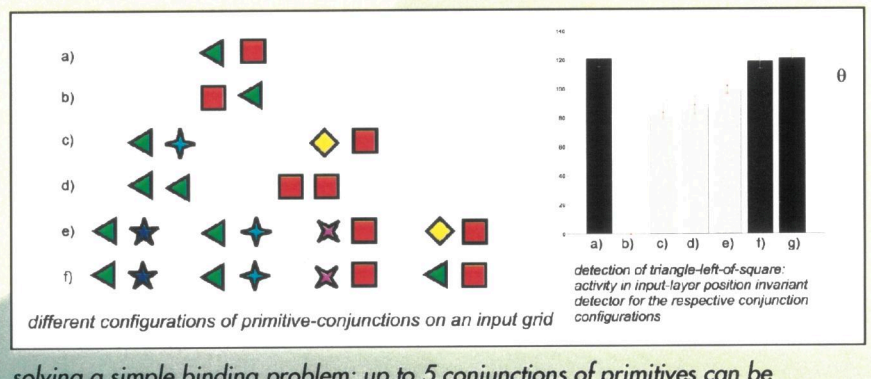


unsupervised clustering of a remote sensing image



function approximation with a spiking neural network

- Recent work has also demonstrated an architecture for solving a simple instance of the *binding-problem* -- efficiently detecting complex composite objects on an input grid (retina).



solving a simple binding problem: up to 5 conjunctions of primitives can be detected simultaneously. Humans exhibit the same limitations.