Hybrid AI based on spiking neural networks

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Spiking Neuron Networks (SNNs) are very attractive because of their asynchronous nature, their ability to manage space-time patterns and their exceptional energy efficiency due to the parsimony of the pulse trains. The learning mechanisms of SNNs are bioinspired and mainly rely on spike-timing-dependent plasticity (STDP), which adjusts the weights of the synaptic connections. Due to the non-differentiable nature of their activation functions, SNNs prove difficult to train with direct back-propagation. Although much progress has been made in encoding and processing sensory information (visual, auditory), the performance of SNNs on reference datasets remains often inferior to that of traditional neural networks [4]

The objective of this thesis is to the developp an hybrid Artificial Intelligence based on SNNs.

Different forms of memory will be studied. A neuroinformatics model that integrates a short-term working memory and a consolidation process of the information saved in the long-term memory will be developped. The network will be built from Izhikevich simple model [2]. It allows the reproduction of up to 23 types of neural behaviour, including cortical excitatory and cortical inhibitory neurons, and the storage of patterns via the construction of oscillator networks. Izikievitch neural networks lead to the appearance of attractors (certain states are repeated ad infinitum) and can be compared to Boolean networks [3].

New forms of learning will be also studied based on time-frequency methods. Several network topologies will be analysed in order to ensure dynamic stability. Special attention will be given to Kohonen-type evolutionary neu-

ral networks where at the end of the learning phase the network is composed of an optimal number of neurons. Indeed, these evolutionary networks are characterised by their accuracy as well as their reduced learning time.

Finally, we plan to study the link between neural networks and logic. Indeed, few works apply SNNs to relational data and symbolic reasoning. This is due to the formalisation of decision rules on the output layer of the network. The latest advances in terms of aggregation of purely qualitative information can be considered to select the relevant information [1].

From an application point of view, this work could be applied to the recognition of objects in images or videos with high noise levels.

Références

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