Fully unsupervised online spike sorting based on an artificial spiking neural network

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Sorting the spiking activity of individual neurons from extracellular recordings remains a challenging issue in neuroscience. Traditional spike-sorting methods rely on an action potential detection combined with a clustering algorithm, and often require offline processing. Here we present a fully unsupervised online spike sorting method based on a spike-timing dependent plasticity (STDP) artificial neural network, a type of network able to perform unsupervised pattern learning. Our STDP network is organized into layers connected by feedforward synapses implementing various plasticity rules. The input signal, band-pass filtered, is continuously fed into the input layer. After a short learning period, the spike trains of the output layer directly reflect the detected and sorted action potentials present in the input signal (Fig 1). This method shows good performances on single electrode compared to classical spike-sorting methods, and can be adapted to process several channels simultaneously. Such STDP network applied to spike sorting opens perspectives to embed neuromorphic hardware in intelligent brain implants, and more generally to achieve complex pattern recognition with neuromorphic architectures.

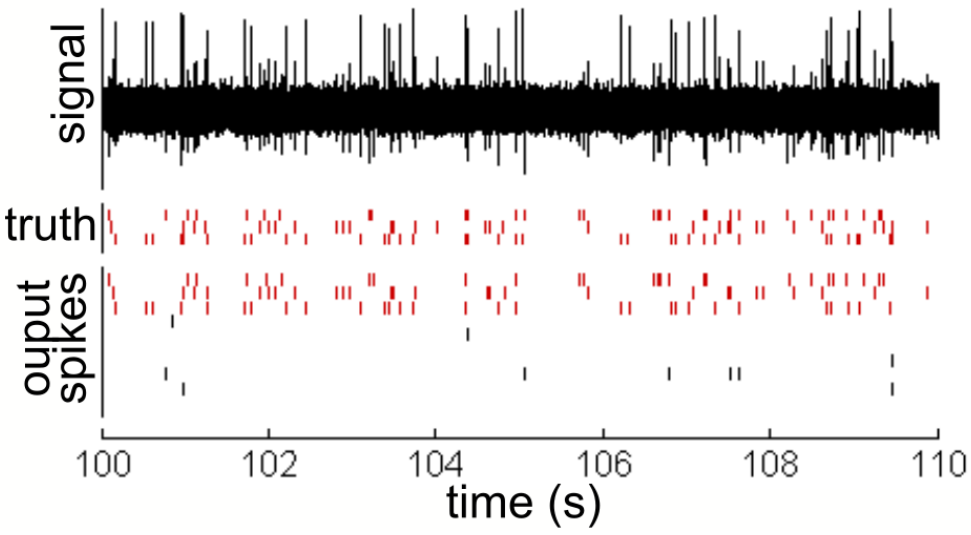

Figure 1 : Activity of the network's output layer compared to ground truth activity on a simulated signal.