Neural network models of supervised learning are usually concerned with processing static spatial patterns of input intensities or of neurons firing rates. A famous example is the perceptron, a model for learning in a single-layer binary neuron. However, in most neuronal systems, neural activities are in the form of time series of spikes. Furthermore, stimulus representation in some sensory systems are characterized by a small number of precisely timed spikes, suggesting that the brain possesses machinery of extracting information embedded in the timing of spikes, not only in their overall rate. Thus, understanding the computational power and limitations of spike-timing based computation and learning is of fundamental importance in computational neuroscience. Gütig and Sompolinsky have recently suggested a simple model, the tempotron, for decoding information embedded in spatio-temporal spike patterns. The model consists of a simple error-correcting on-line learning algorithm applied to an Integrate and Fire neuron.

In this work we present a theoretical study of the computational power of the tempotron. Our theory enables us to calculate the tempotron's capacity and the statistical properties of the tempotron's membrane potential and output spikes as a function of the various time scales of the system's dynamics.

The strong non-linear nature of the tempotron's classification entails that the common and intuitive assumption that a neuron's function is characterized by its synaptic efficacies no longer holds. This is a general property of any Integrate and Fire neuron and also holds for more realistic models of a neuron.

The lecture will take place at the ELSC-ICNC lecture hall (Silverman Bldg., Wing 3, 6th floor - Edmond J. Safra Campus)

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