Poster - Session 4

Role of electric synapses in spike train statistics of integrate and fire neural networks

Rodrigo Cofré, Bruno Cessac

NeuroMatComp, INRIA, Sophia Antipolis, France

Communication between neurons involves chemical synapses as well as electric synapses (gap junctions). On theoretical grounds, the role of gap junctions in encoding and shaping collective dynamics as well as spike train statistics is quite less understood than the role of chemical synapses. In this work, we analyse mathematically the collective spike train statistics in conductance-based Integrate and Fire neural networks with chemical and electric synapses. We show that this statistics is characterized by a Gibbs distribution whose potential can be explicitly computed. This provides a firm theoretical ground for recent studies attempting to describe experimental rasters in the retina as well as in the parietal cat cortex by Gibbs distributions and maximum entropy principle. The main observation resulting from our analysis is that spike statistics is *indecomposable*. The probability of spike patterns does notfactorize as a product of marginal, per-neuron, distributions. As a consequence, in that model, *there is absolutely no way to defend that neurons act as independent sources*. Additionally, correlations mainly result from the chemical and electrical interactions between neurons (correlations persist even if there is no external current / stimulus). We also point out that the Gibbs distribution obtained in our model is quite more complex than Ising model or Generalized Linear Models used in retina spike train analysis. Especially, it involves spatio-temporal spike patterns is non stationary, and correlations are induced by dynamics not only by stimulus. Handling spatio-temporal events in Gibbs distributions requires more subtle algorithms than simultaneous events as those considered in the Ising model and its extensions. This work suggest that electric synapses could have a stronginfluence in spike train statistics of biological neural systems, especially theretina where gap junctions connections between several cells-type (e.g. amacrine and ganglion cells or amacrine-bipolar) are ubiquitous.

Rodrigo Cofre, Bruno Cessac. Dynamics and spike trains statistics in conductance-based integrate-and-fire neural networks with chemical and electric synapses . *Chaos, Solitons and Fractals, submitted,* 2012.