Learning the Synapses of a Network of Spiking Neurons

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The influential paper by Galves and Locherbach (2013), where a network of spiking neurons is modelled as a system of interacting point processes, has led naturally to the question of inferring the neighborhood of each neuron, which mathematically represents the synaptic structure of the network. A first attempt in this direction, due to Duarte et al (2019), exploited the variable but finite length of the memory of the process. The identification of synaptic links results by estimating in a nonparametric fashion the conditional intensities corresponding to the various histories of the whole set of neurons: as a consequence the method requires a large amount of storage. Later on we pursued a different approach, using the more traditional correlation analysis pionereed by Brillinger (1975), but tailored to the Galves and Locherbach model, in which the intensity is reset to a reference value after each spike. This correlation technique needs to retrieve from memory only the spiking activity of pairs of neurons, hence it is useful also in case of partially observed networks. In a first contribution (De Santis et al, 2022) we proved the consistency of the technique for markovian networks with intensities bounded from above and below away from zero; a more recent application (De Santis et al, 2023) extends this result to a class of non-markovian networks, where excitatory connections are instantaneous and inhibitory ones are delayed, which is a motivated by the olfactory system of some insects (Luo, 2015).

References

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