سمینار هفتگی ماده چگال نرم

Revealing hidden neuronal microcircuits from correlation among spiking neurons: A statistical physics approach

Abstract

The information transfer and processing in our brain relies on cells called neurons. They are connected to each other through connections, called synapse, and form an interconnected complex network, known as gray matter. Each neuron receives signals from its upstream neurons, generates a spike, and passes it to many downstream neurons. To understand this complex structure, one should have learnt the connectivity map of neurons, in a living brain. However, it is impossible to record from one neuron and all its hidden inputs to determine the influential synapses which dominate the activity of that neuron. Although there are methods to find the connectivity among recorded (observed) neurons, the majority of downstream neurons remain unobserved. Here, firstly we find the analytical relation of how input potential of signaling input on top of many other inputs can change the spiking density of neurons. Then using this nonlinear relation, we connect the hidden shared motifs (in different architectures of excitatory and inhibitory inputs) with the interactions of neuronal spiking, observed in experimental data. We present a guide map in the space of neural interactions (i.e pairwise and triple-wise interactions) to infer the influential hidden circuits from the data. We checked the validity of the guide map by extensive simulations using multicompartmental neuron models of Blue Brain Project. Applying the guide map to monkey and mouse data, we observed the hidden motif of excitatory inputs shared between each pair of three neurons is the motif behind most of the data. We hope experimentalists use our guide map, to reveal the hidden motifs behind their data.

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