Numerical analysis of large scale neural networks using mean field techniques

In the first part of this talk I will introduce you to a new mean field reduction for noisy networks of conductance based model neurons. This approach allow us to describe the dynamics of a network by a McKean-Vlasov-Fokker-Planck equation. This a non linear and non local partial differential equation that characterizes the probability density function of the network.

On a second part of this talk I will show you several simulations whose objective was to study the behavior of extremely large networks. For this we used the previous reduction as a simulation tool. On each of this numerical experiments we have solved its corresponding McKean-Vlasov-Fokker-Planck equation instead of the original large system of stochastic differential equations. All this is done with the help of a GPU cluster available at our laboratory.

The results of this experiments show how the speed of convergence towards a stationary probability density can be tuned by the level of external noise in the system. The final solution in all of the cases is similar and can be used as a tool for encoding information. The simulations also show that the noise in the synapses does not have a large influence on the behavior of the system.

On the final part of this talk I will present a model of a hypercolumn of the primary visual cortex where each orientation is represented by a population of neurons which can be described by a McKean-Vlasov-Fokker-Planck equation. We have simulated this model by solving a system of partial differential equations. The results show that the system is able to enhance an original, weakly tuned, angle selection.