STUDY OF SYNAPTIC PLASTICITY VIA RANDOM GRAPHS

Tatyana S. Turova

Mathematical Center, Lund University, S-22100, Lund, Sweden
tatyana@maths.lth.se

We introduce and study a mathematical model for the dynamics of synaptic weights in a neuronal assembly. We use directed multi-graphs to describe the states of a network. The vertices of the graph represent the neurons. The (random) directed edges of the graph are associated with the junctions between the neurons. We assume that the probability that there exists at least one edge between two vertices represents the synaptic weight between the corresponding neurons. The activity of each neuron is described by the stochastic point process generating spikes. This process governs appending and deleting edges from the vertex associated with this neuron.

Due to the stochastic dynamics at any given moment of time we have a random graph of the connections. However, in the thermodynamic limit we observe stable patterns. We find the functional dependence between the structure of the limiting patterns and the parameters of the activity of a single neuron. We will show that the cycles are the most stable structures when the Hebb rule is implemented into the dynamics of the model. We discuss the role of cycles for the synchronization of the neuronal activity.