

Neural network of LIF neurons with synaptic connections and gap-junctions

Single neuron dynamics

$$C \frac{dV_k}{dt} = -g_L(V_k - V_L) + I_{syn}^k + I_{gap}^k + I_{ext} \quad (1)$$

Spike generation

if $V_k > V^T$ *then* $V_k = V_{reset}$ *during* t_{ref}

Synaptic current

$$\tau_s \frac{dI_{syn}^k}{dt} = -I_{syn}^k + \sum_{i=1}^N \sum_{j=1}^{sp} \delta_i(t - t_j) \quad (2)$$

Gap-junction current

$$I_{gap}^{k,m} = \pm g_{gap}(V_k - V_m) \quad (3)$$

External input

if $t < t_{st}$ *then* $I_{ext} = step$

else $I_{ext} = 0$

Connectivity

N – number of neurons

sp – spikes in the spike train

Indexes

k – index over neurons

m – index of connected neurons

i – index over synapses

j – index over spikes

Summation over synaptic connections is organised by sparse connectivity matrix **A**

Gap-junctions are located in the same places as synaptic connections according to matrix **A**

