A: Model Summary

Populations
Multiple modules, each one composed of 1 excitatory and 1 inhibitory sub-population

Topology
None

Connectivity
Sparse, random recurrent connectivity with random or topographically structured feed-forward projections (fixed in-degrees)

Neuron Model
Leaky integrate-and-fire, fixed voltage threshold, fixed absolute refractory time, no adaptation

Synapse Model
Exponentially decaying postsynaptic currents, static synaptic weights, fixed delays

Plasticity
None

Input
Stochastic background spikes and inhomogeneous Poisson spikes onto \(d_0N_E\) excitatory and \(d_0N_I\) inhibitory neurons in SSN_0

Measurements
Spiking activity, membrane potentials

B: Populations

| Name | Elements | Size |
|------|----------|------|
| \(E_i\) | iaf_psc_exp | 8000 |
| \(I_i\) | iaf_psc_exp | 2000 |

C: Neuron Models

| Name | Subthreshold Dynamics |
|------|-----------------------|
|      | if \(t > t^* + \tau_{\text{ref}}\)  
      | \[
      \tau_m \frac{dV_i(t)}{dt} = (V_{\text{rest}} - V_i(t)) + R_m \left( I_{E}^i(t) + I_{I}^i(t) + I_{X}^i(t) \right)  
      \]  
      | else  
      | \(V(t) = V_{\text{reset}}\)  

Spiking
If \(V(t^-) < V_{\text{th}}\) OR \(V(t^+) \geq V_{\text{th}}\)  
1. set \(t^* = t\)  
2. emit spike with time stamp \(t^*\)

D: Synapse Models

Synaptic Transmission
\[
\tau_s \frac{dI_{\beta}^j(t)}{dt} = -I_i(t) + \tau_s \bar{I}_{\beta} \sum_k \delta(t - t_k^j)  
\]
with postsynaptic potential \(\text{PSP}_{ij}(t) = \bar{I}_{\beta} \frac{R_m \tau_m}{\tau_s - \tau_m} \left( e^{-t/\tau_s} - e^{-t/\tau_m} \right) \Theta(t)\)

and Heaviside function \(\Theta(t) = \begin{cases} 1 & t \geq 0 \\ 0 & \text{else} \end{cases}\)

The synaptic efficacy (weight) corresponds to the PSP amplitude:
\[
J_{\beta} = \bar{I}_{\beta} \frac{R_m \tau_m}{\tau_s - \tau_m} \left( \frac{\tau_s}{\tau_s - \tau_m} - \frac{\tau_m}{\tau_s - \tau_m} \right)  
\]

E: Input

| Type | Target | Description |
|------|--------|-------------|
| poisson_generator | \(E_0, I_0\) | Total rate \(\nu_X \cdot K_X\) |
| poisson_generator | \(E_i, I_i\) for \(i > 0\) | Total rate \(0.25 \cdot \nu_X \cdot K_X\) |
| inhomogeneous_poisson_generator | \(E_0^{(k)}, I_0^{(k)}\) for \(S_k \in S\) | Inhomogeneous Poisson process with rate \(\nu_{\text{stim}}\), changing every 200 ms |
| inhomogeneous_poisson_generator | \(E_i^{(j)}, I_i^{(j)}\) for \(S_i' \in S'\) | |

F: Measurements

Spiking activity, membrane potentials

Table 1: Tabular description of current-based (baseline) network model after [94].