

Cortical Microcircuit Simulation Project

Mapping Neuron Types, Connectivity
& Computational Functions

Reference: Potjans, T. C., & Diesmann,
M. (2014).

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Neuron Types

- Layer 2/3 Excitatory (E_{23}): Regular-spiking pyramidal
- Layer 2/3 Inhibitory (I_{23}): Fast-spiking interneurons
- Layer 5 Excitatory (E_5): Thick-tufted bursting pyramidal
- Layer 5 Inhibitory (I_5): Somatostatin/parvalbumin interneurons

Connectivity Patterns

- Connection probabilities defined per pre→post population:
- $E_{23} \rightarrow E_{23}$: 0.10 $E_{23} \rightarrow I_{23}$: 0.06 $E_{23} \rightarrow E_5$: 0.04 $E_{23} \rightarrow I_5$: 0.02
- $I_{23} \rightarrow E_{23}$: 0.12 $I_{23} \rightarrow I_{23}$: 0.10 $I_{23} \rightarrow E_5$: 0.05 $I_{23} \rightarrow I_5$: 0.04
- $E_5 \rightarrow E_{23}$: 0.08 $E_5 \rightarrow I_{23}$: 0.03 $E_5 \rightarrow E_5$: 0.09 $E_5 \rightarrow I_5$: 0.02
- $I_5 \rightarrow E_{23}$: 0.07 $I_5 \rightarrow I_{23}$: 0.05 $I_5 \rightarrow E_5$: 0.06 $I_5 \rightarrow I_5$: 0.10

Computational Functions

- 1. Balanced Asynchronous Irregular activity: fluctuation-driven AI regime.
- 2. Layer-specific gain modulation:
 - - Feedforward ($E_{23} \rightarrow E_5$) for bottom-up processing
 - - Feedback ($E_5 \rightarrow I_{23}$) for top-down control
- 3. Population coding: orientation tuning and receptive field refinement

Summary & Next Steps

- • Provides a framework to simulate Corticon-induced E/I imbalance.
- • Enables in silico rescue experiments: modulate conductances, external drive, STDP.
- • Next: implement rescue protocols and analyze recovery trajectories.