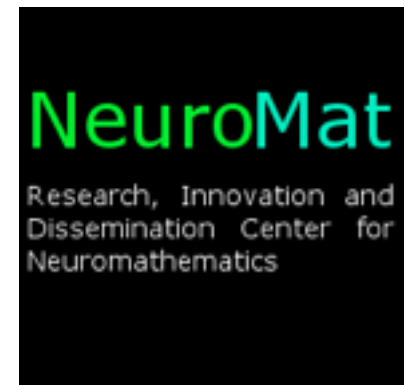


The Potjans-Diesmann local microcircuit model using different neuron classes for excitatory and inhibitory neurons

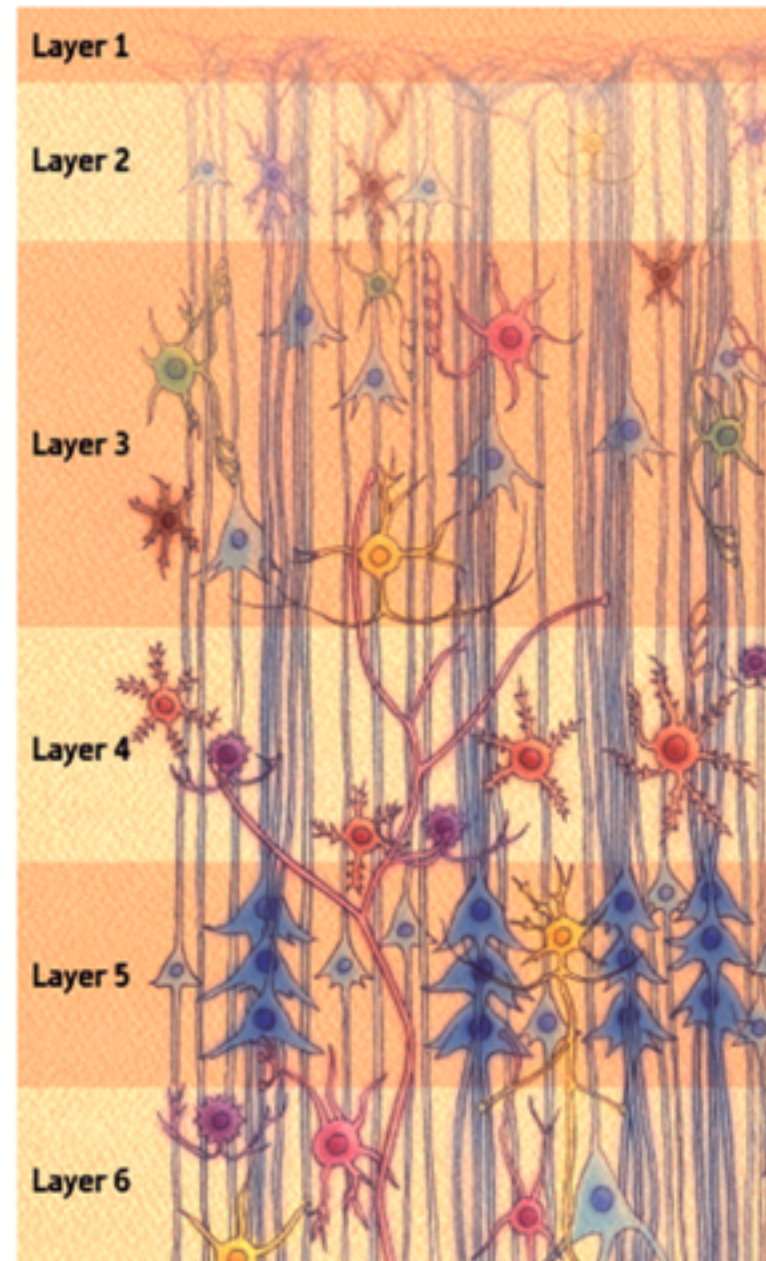
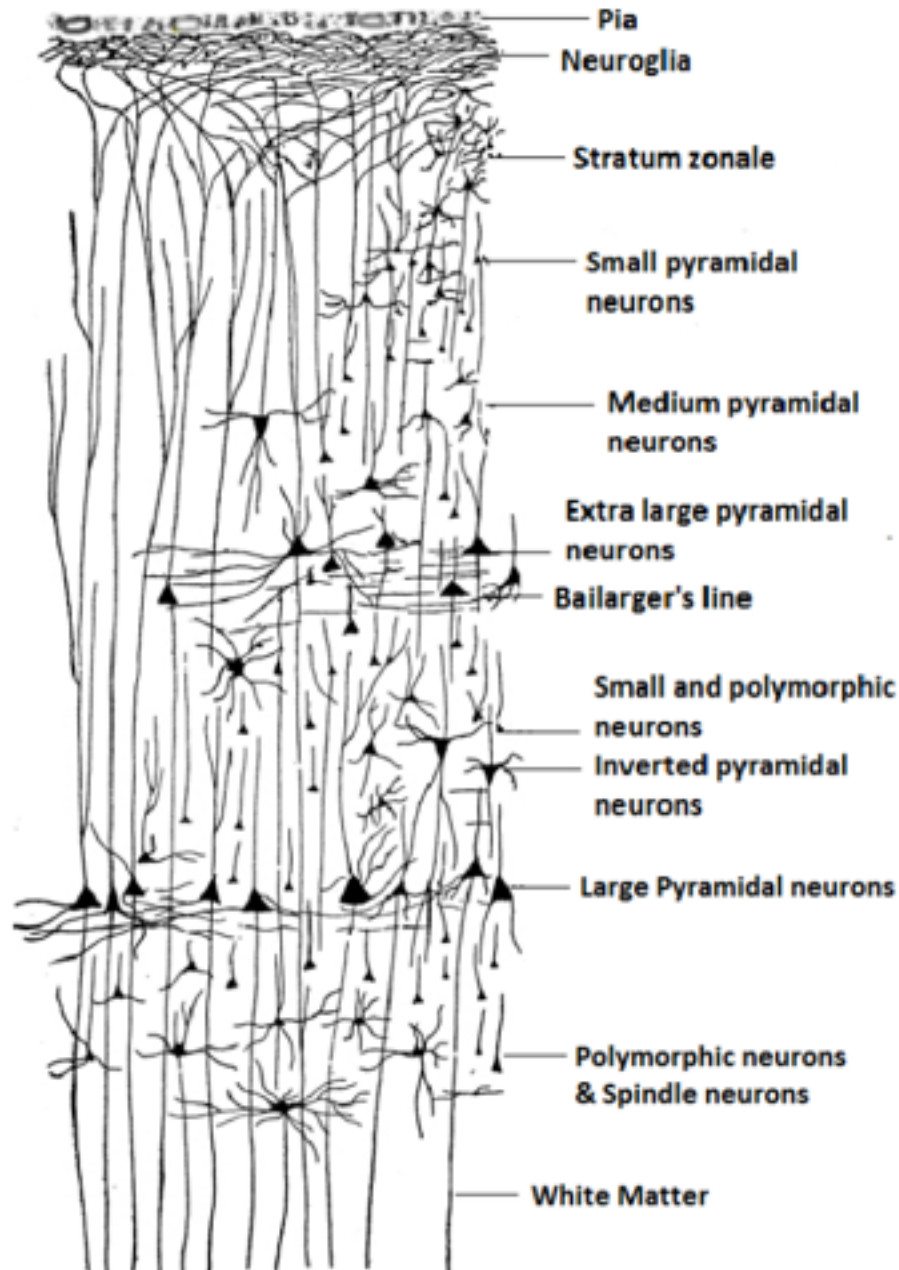
Nilton L. Kamiji, Renan O. Shimoura, Vinicius L. Cordeiro, Rodrigo F.O. Pena & Antonio C. Roque

Department of Physics, FFCLRP

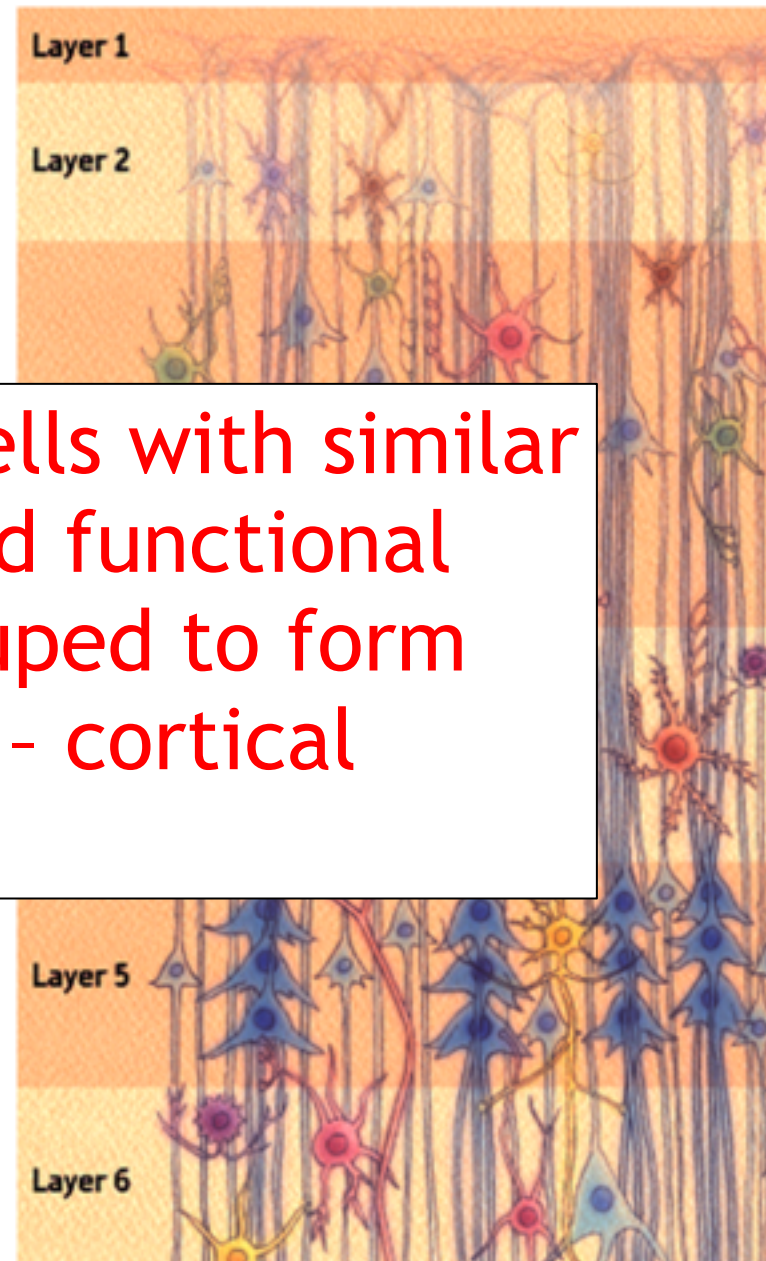
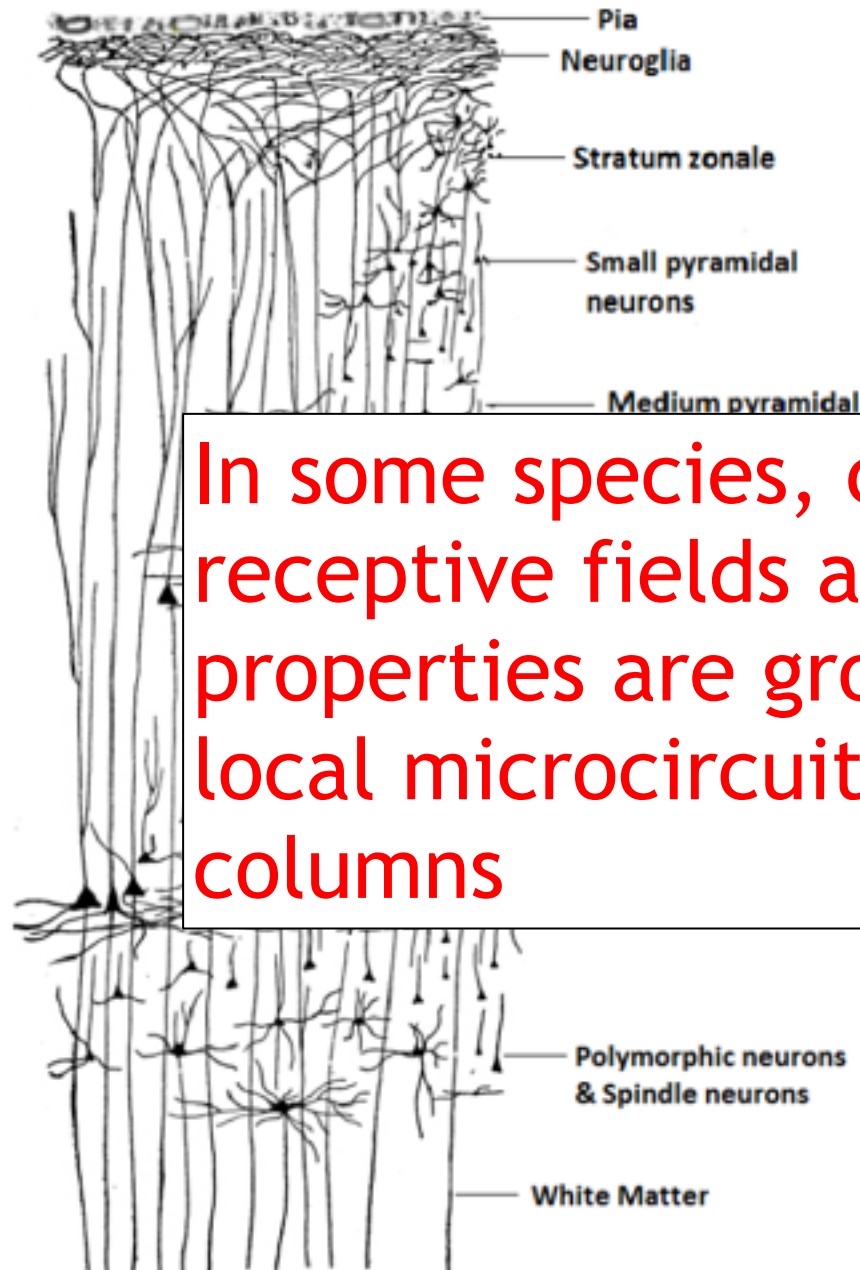
University of São Paulo, Ribeirão Preto, SP, 14040-901, Brazil



Histological Structure of the Cerebral Cortex



Histological Structure of the Cerebral Cortex

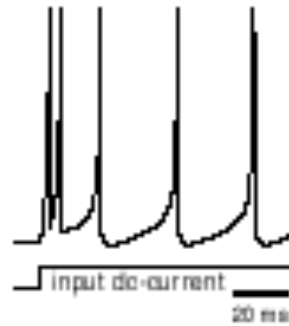


In some species, cells with similar receptive fields and functional properties are grouped to form local microcircuits - cortical columns

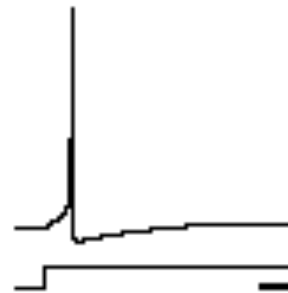
Examples of response properties in cortical neurons

(Izhikevich, 2000)

(A) tonic spiking



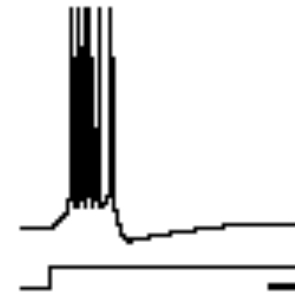
(B) phasic spiking



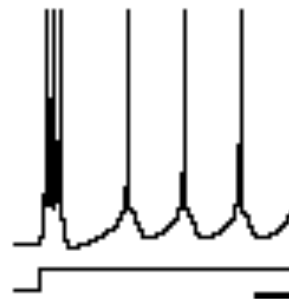
(C) tonic bursting



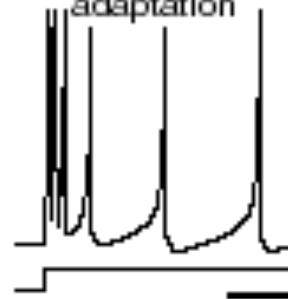
(D) phasic bursting



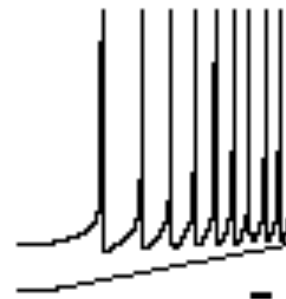
(E) mixed mode



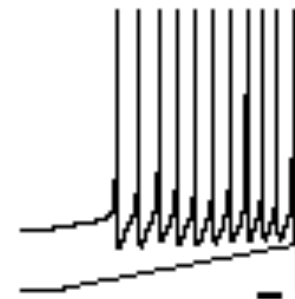
(F) spike frequency adaptation



(G) Class 1 excitable



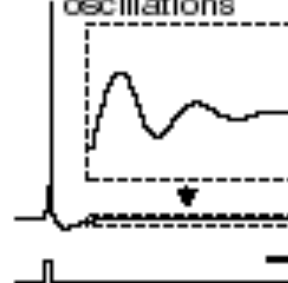
(H) Class 2 excitable



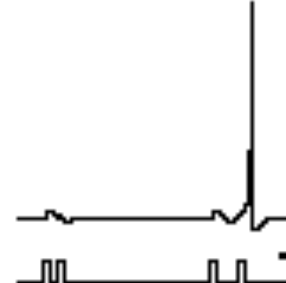
(I) spike latency



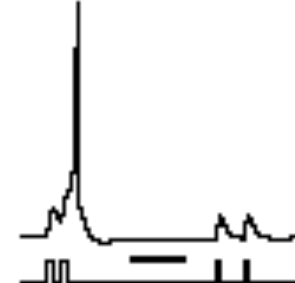
(J) subthreshold oscillations



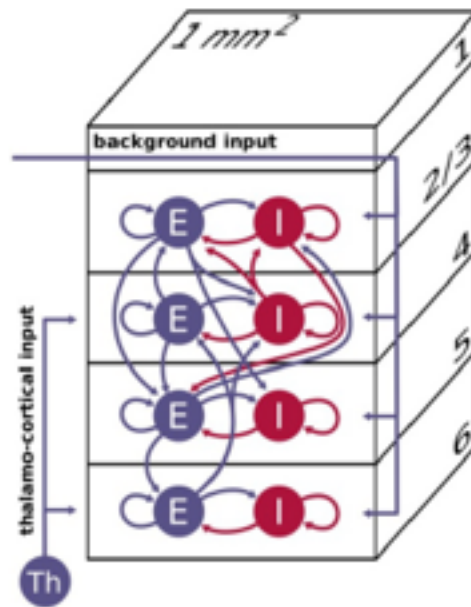
(K) resonator



(L) integrator

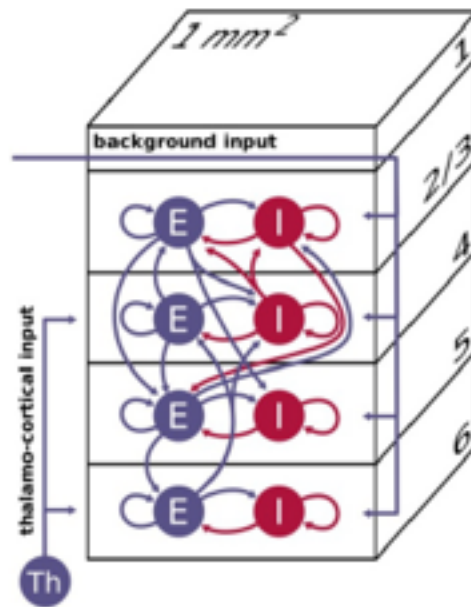


Study the behaviour of the Potjans-Diesmann cortical microcircuit (Potjans and Diesmann, 2014) based on different classes of neurons models (excitatory and inhibitory)



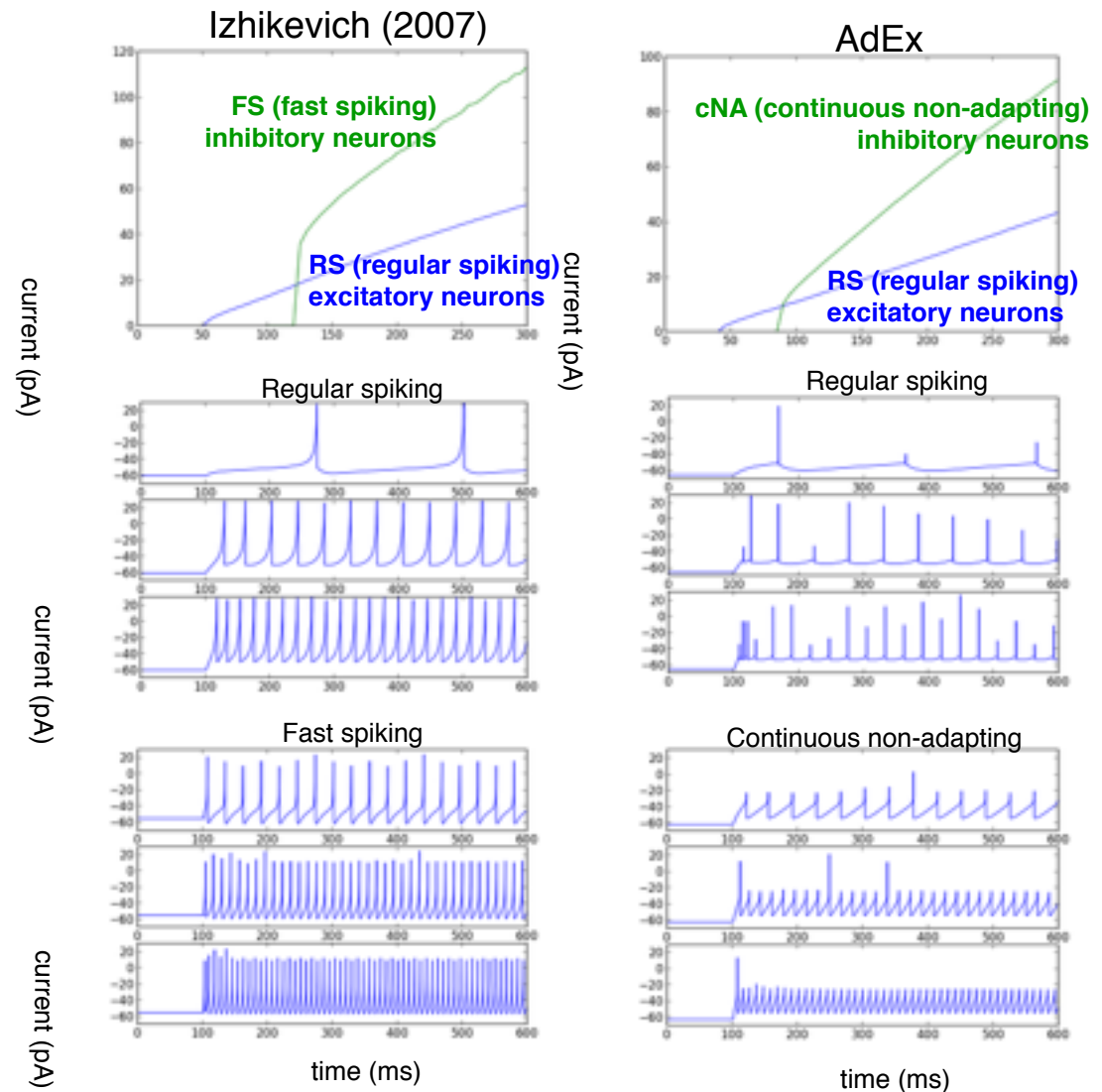
- ~ 80.000 neurons
(80% excitatory, 20% inhibitory)
- ~ 10^9 synapses
- Same LIF (leaky integrate-and-fire) model for both excitatory and inhibitory neurons (iaf_psc_exp model in NEST)
- Inhibitory synapse weight is 4 times greater than excitatory synapses
- Poissonian/DC/Thalamic input
- Realistic model in terms of neural connectivity

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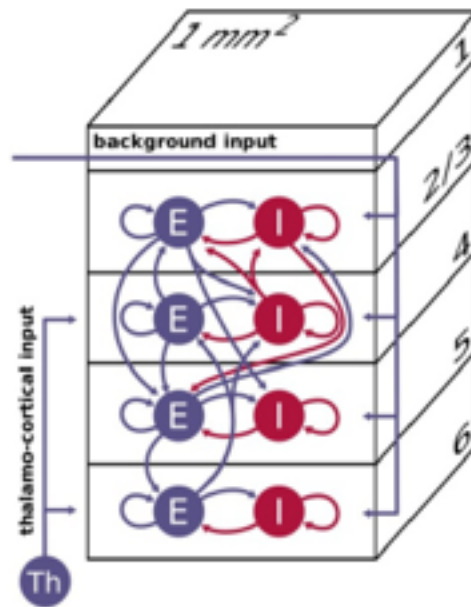


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Izhikevich and AdEx neuron models

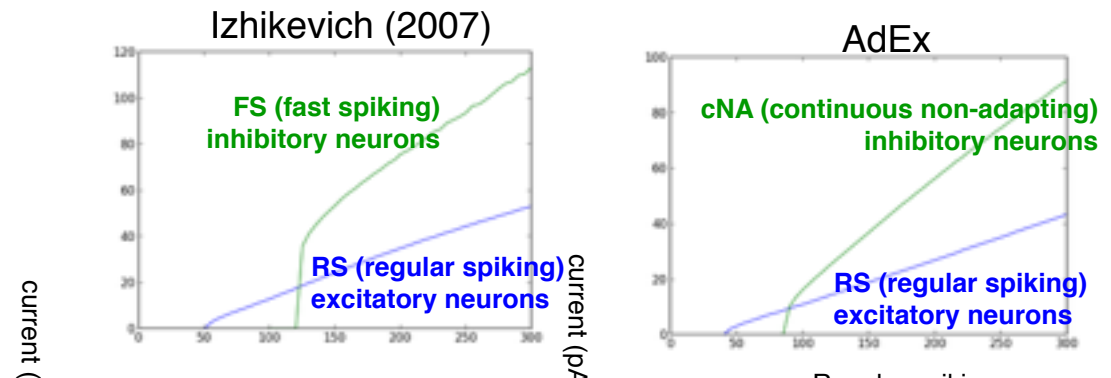


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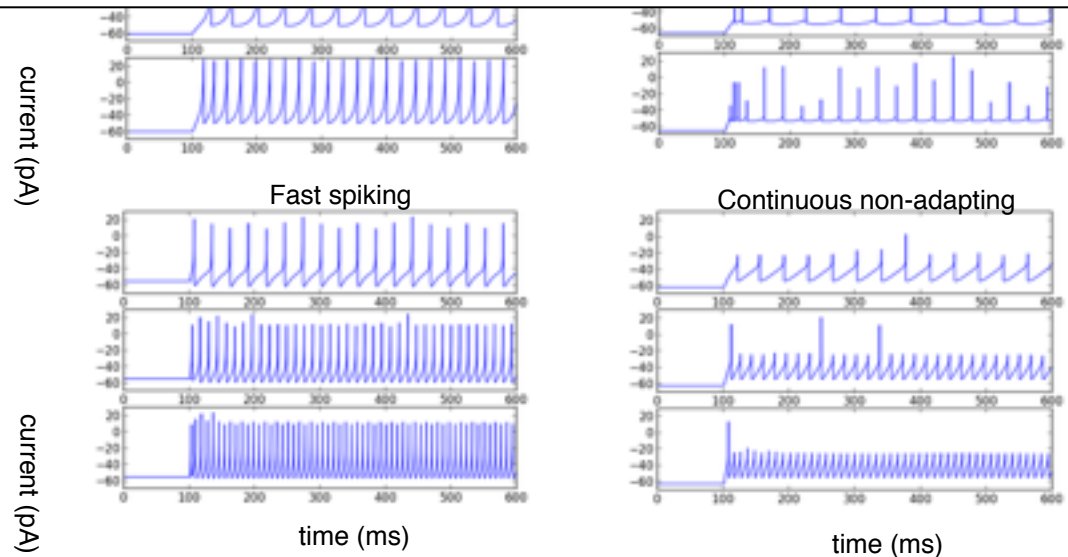


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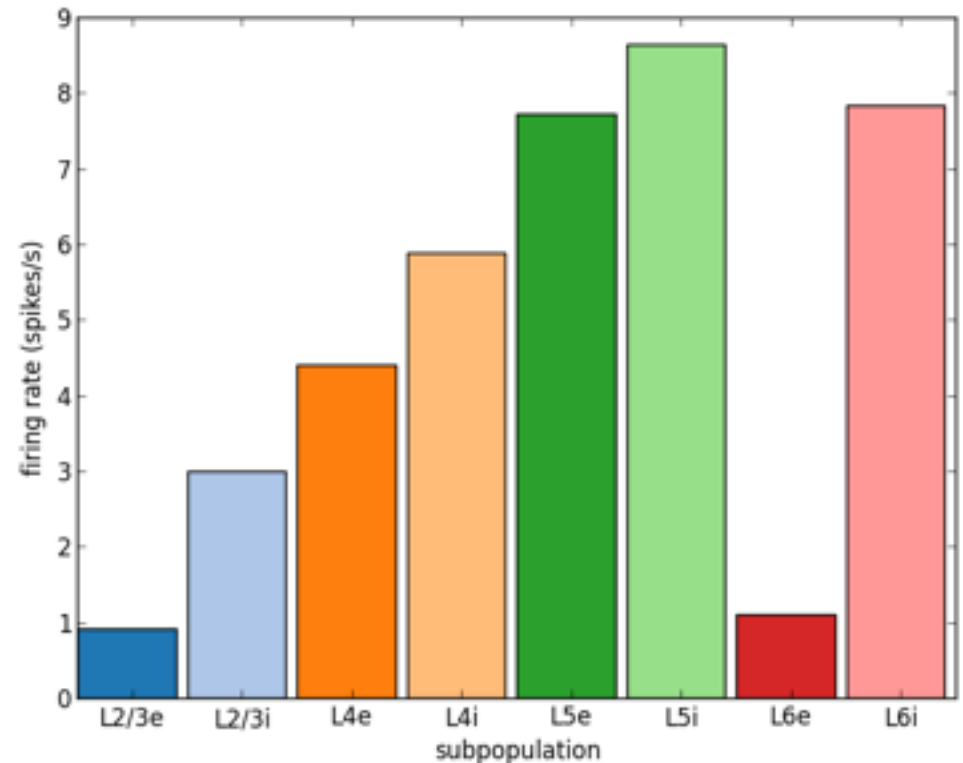
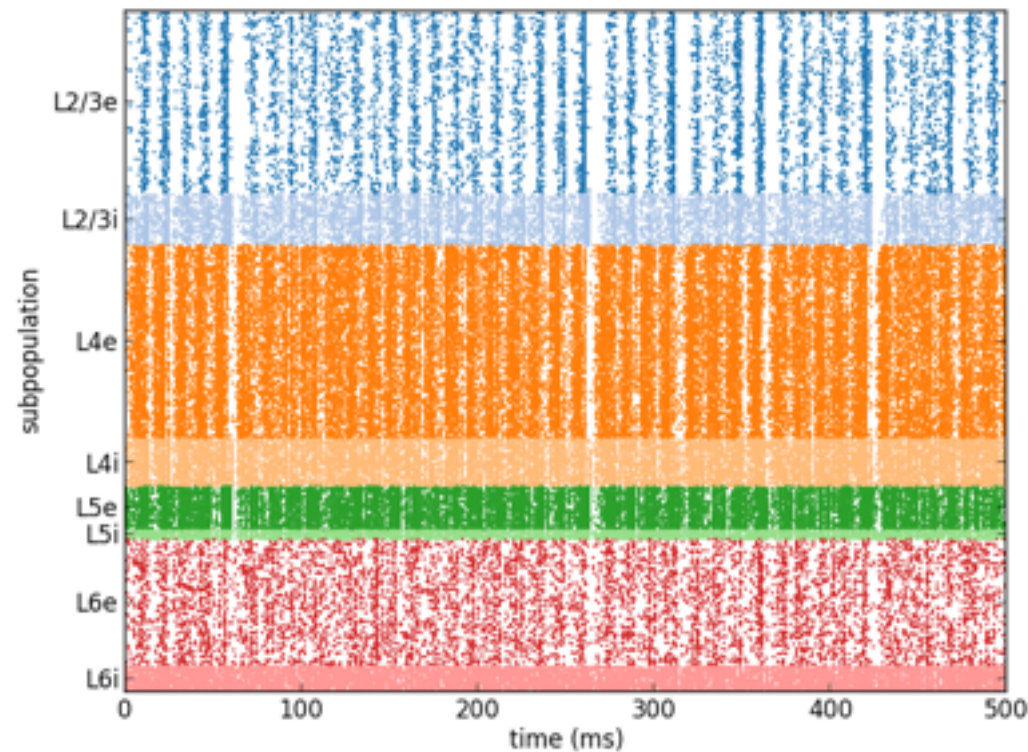
Izhikevich and AdEx neuron models



And of course, it's corresponding Galves-Locherbach stochastic neuron model



PD microcircuit model with LIF neurons (original configuration)

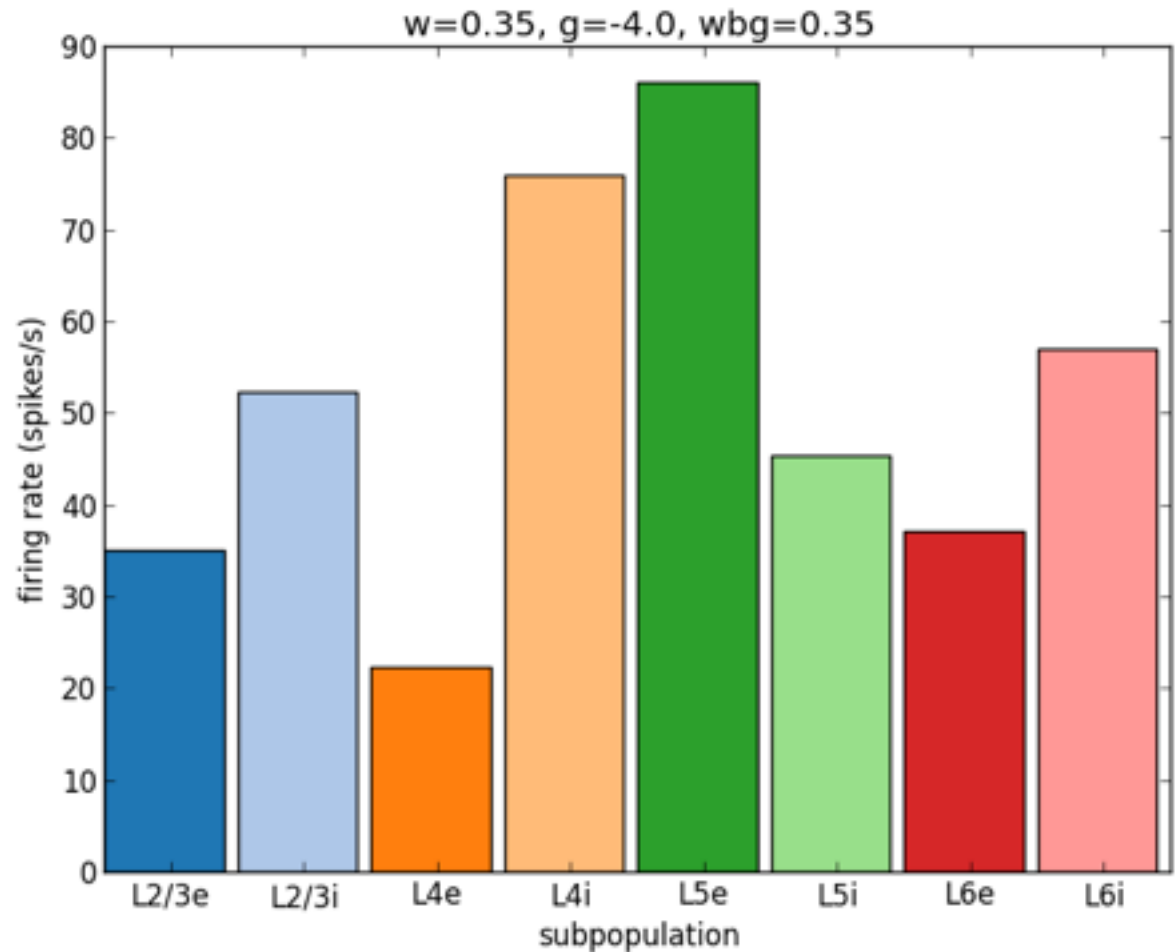
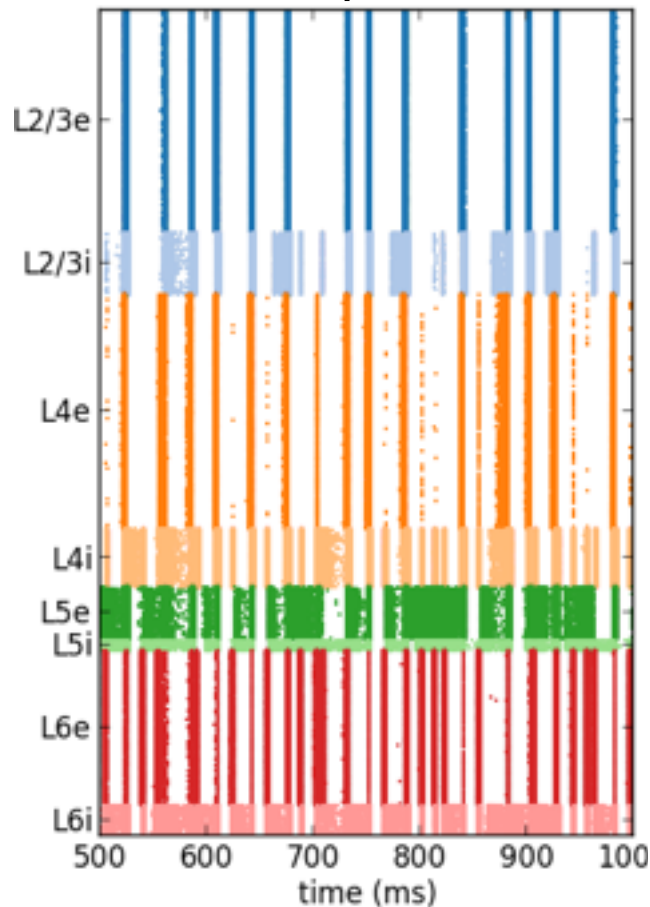


Properties:

- 1) asynchronous and irregular
- 2) excitatory layers show lower firing rates;
- 3) layer 6e with extremely lower firing rate compared to 6i

PD microcircuit model with Izhikevich RS and FS neurons in NEST (FULL scale raster plots)

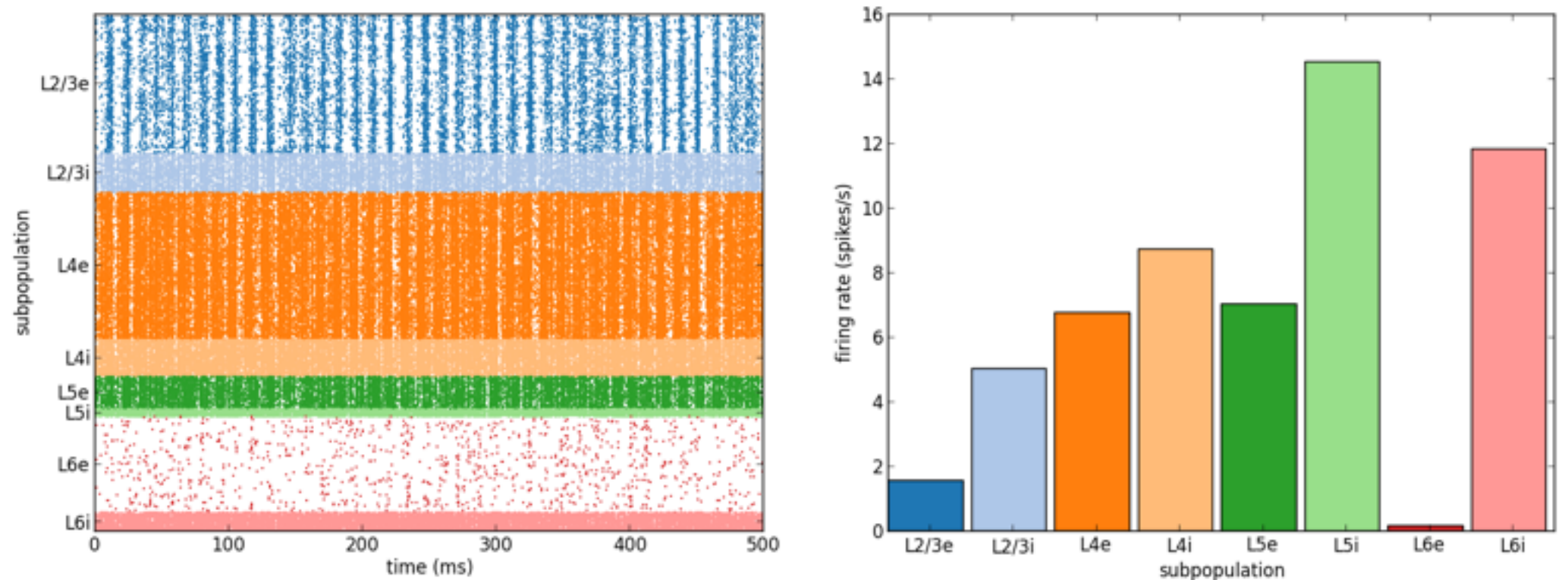
Excitatory synaptic weight (w) was adjusted to display similar response properties to the same poissonian input



The synchrony as well as the overall firing rate was much higher

Modified PD microcircuit model

LIF neurons replaced by $GL_{Izhikevich}$ RS neurons



Spike traces and firing rates were qualitatively reproduced

- Higher firing rate compared to original LIF version

Higher firing rate was obtained



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