Event-and-time driven simulator accelerated with CPU-GPU co-processing

Francisco Naveros[1], Jesús A. Garrido[2,3], Niceto R. Luque[1], Richard R. Carrillo[1], Eduardo Ros[1]

[1]Dept. of Computer Architecture and Technology, University of Granada, CITIC, Spain;
[2]Consorzio Interuniversitario per le Scienze Fisiche della Materia (CNISM), Pavia, Italy;
[3]Dept. Of Brain and Behavioral Sciences, Universiti of Pavia, Italy.

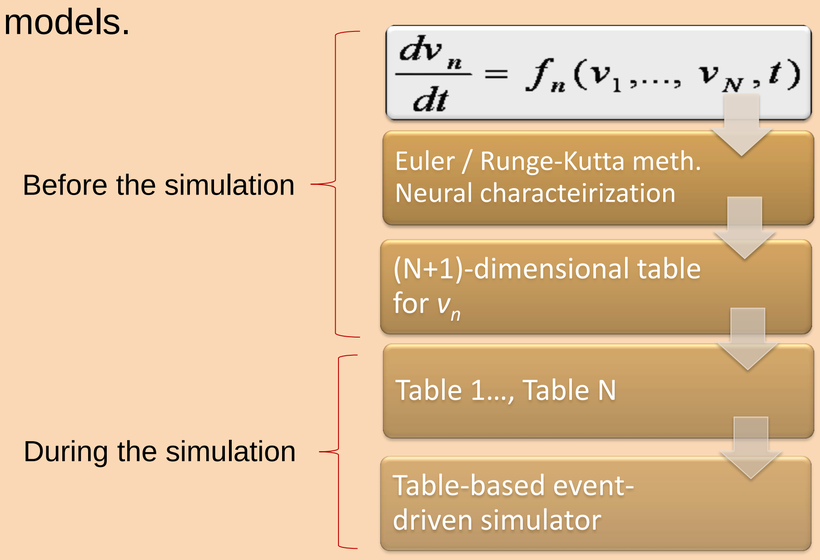
Motivation

1. Simulation of biologically plausible spiking neural structures.
2. Simulation of different neural models and different neural network with different connection delay.
3. Real-time simulation of middle-scale neural networks (tens of thousands of neurons).

Event-driven Methods

❑These methods are better suited to simulate neural networks presenting low and sparse activity with networks of a few input synapses per neuron.

❑Based on look-up tables to characterize neuron models.



❑The simulation precision and performance depend on:

- ❖Table size and its access mode (interpolation)
- ❖Table structure (coordinates distribution)

  If a neuron behavior exhibits abrupt changes along a specific dimension denser sampling is required.

  It is also possible to use non-uniform coordinate distribution.

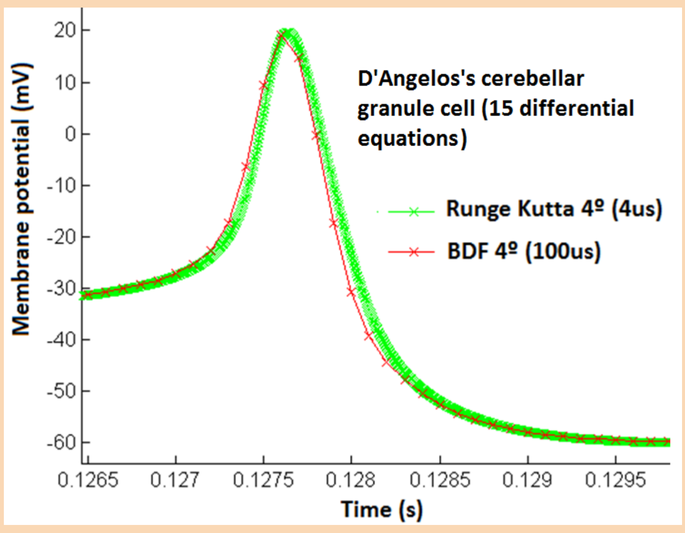
Time-driven Methods

❑These methods are better suited to simulate high activity neural networks:

- ❖ CPU methods for small-scale neural networks.
- ❖ GPU methods for large-scale neural networks

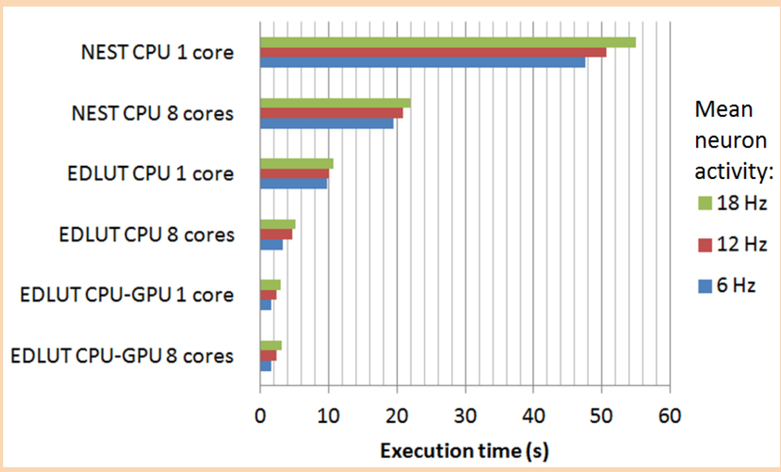
❑The precision and performance of the simulation depend on:

- ❖The integration step size.
- ❖The integration method:
  - •Euler.
  - •Runge Kutta.
  - •Backward Differentiation Formulas (BDF).



EDLUT vs. NEST

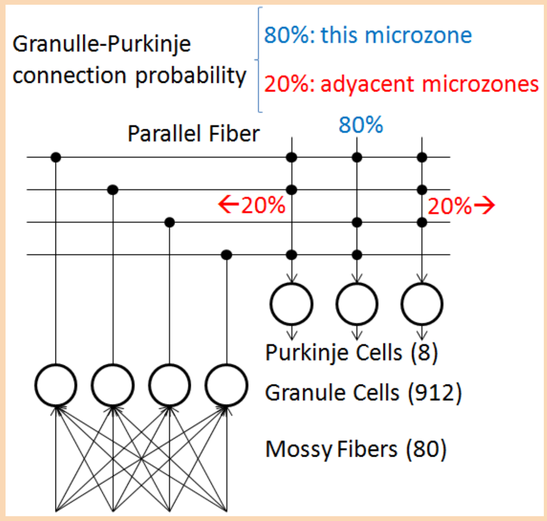
❑10 thousand neurons and 620 thousand synapses (10 seconds of simulation).



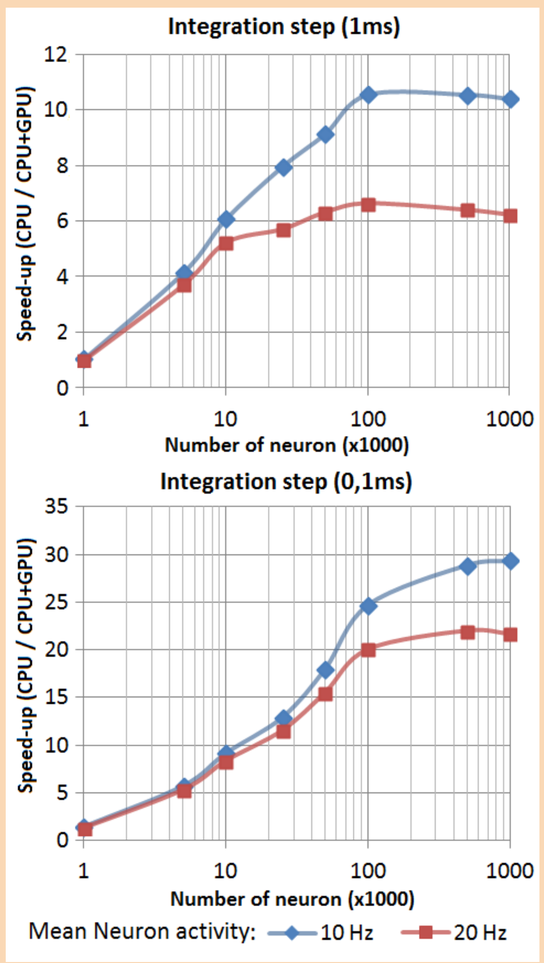
Experimental Results

❑Comparative study between CPU and CPU-GPU approaches.

❑Cerebellar microzone: A thousand neurons and 12,4 thousand synapses.



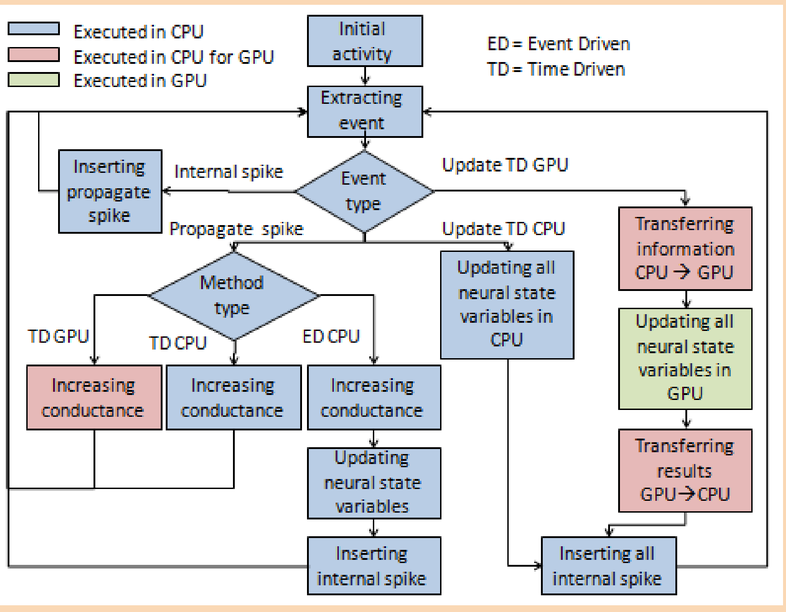
❑We increase the network size by replicating this structure (as microzones).

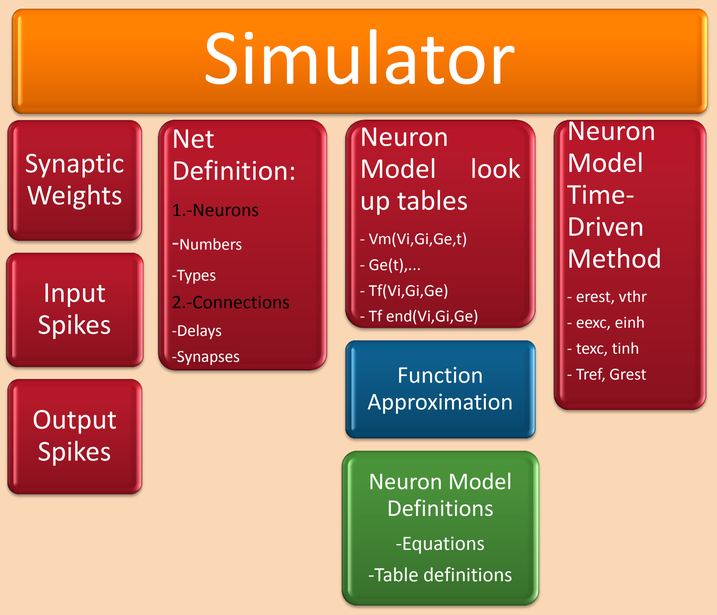


❑Intel core i7 2600k 3,4 GHz CPU.

❑NVIDIA GTX 470 GPU.

EDLUT flow diagram (co-processing) and interface scheme





New features in EDLUT

❑Time-driven and event-driven hybrid simulations.

❑High performance with hybrid CPU-GPU co-processing.

❑New integration methods for stiff neural models (BDF).

❑New detailed cell models with time driven methods.

FURTHER INFORMATION: If you are interested in this work and need further details, the source code is available at http://code.google.com/p/edlut/ and do not hesitate to contact us at fnaveros@ugr.es or jesus.garrido@unipv.it

ACKNOWLEDGMENTS: This work was supported in part by the EU project REALNET (IST-270434) and CEREBNET (ITN-238686)