



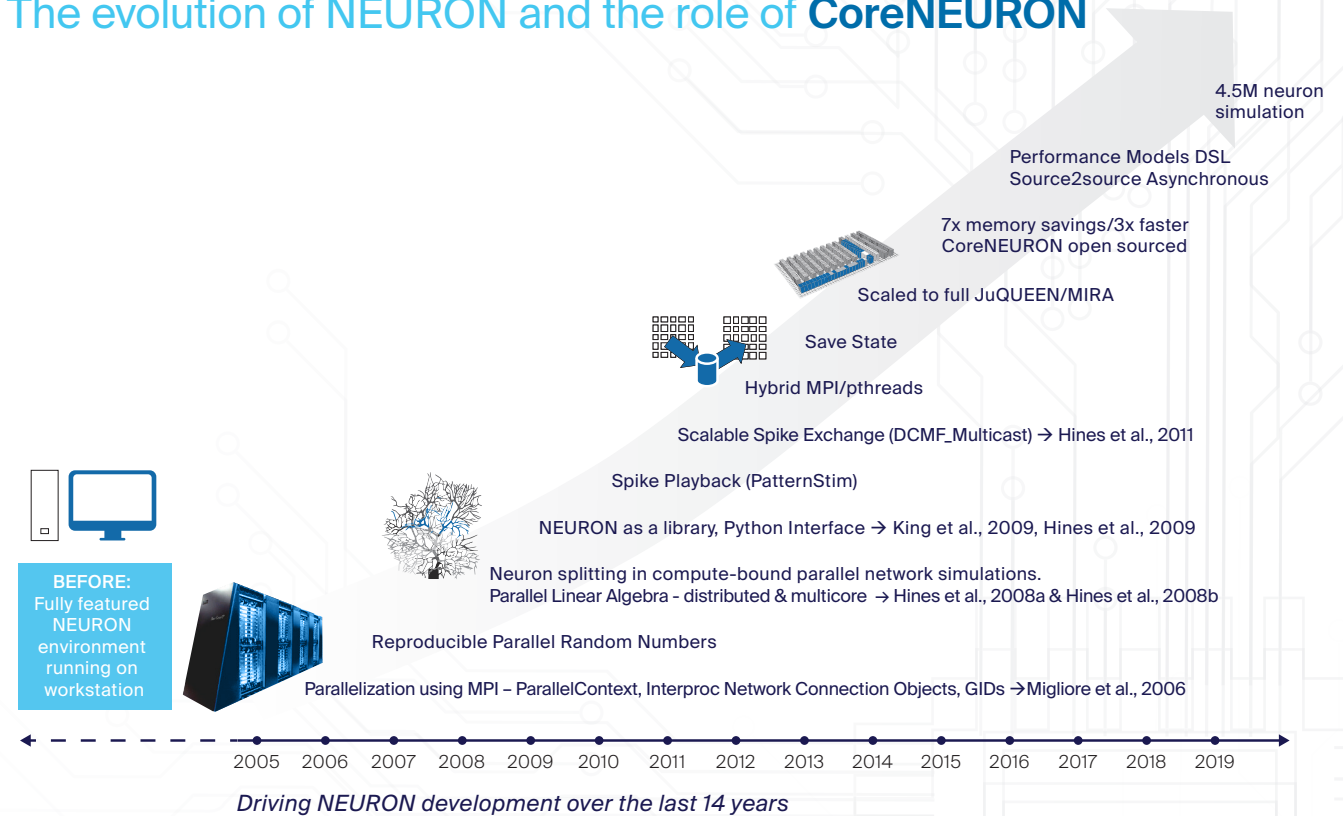
Blue Brain  
collaboration

# CoreNEURON

An optimized compute engine for the NEURON simulator

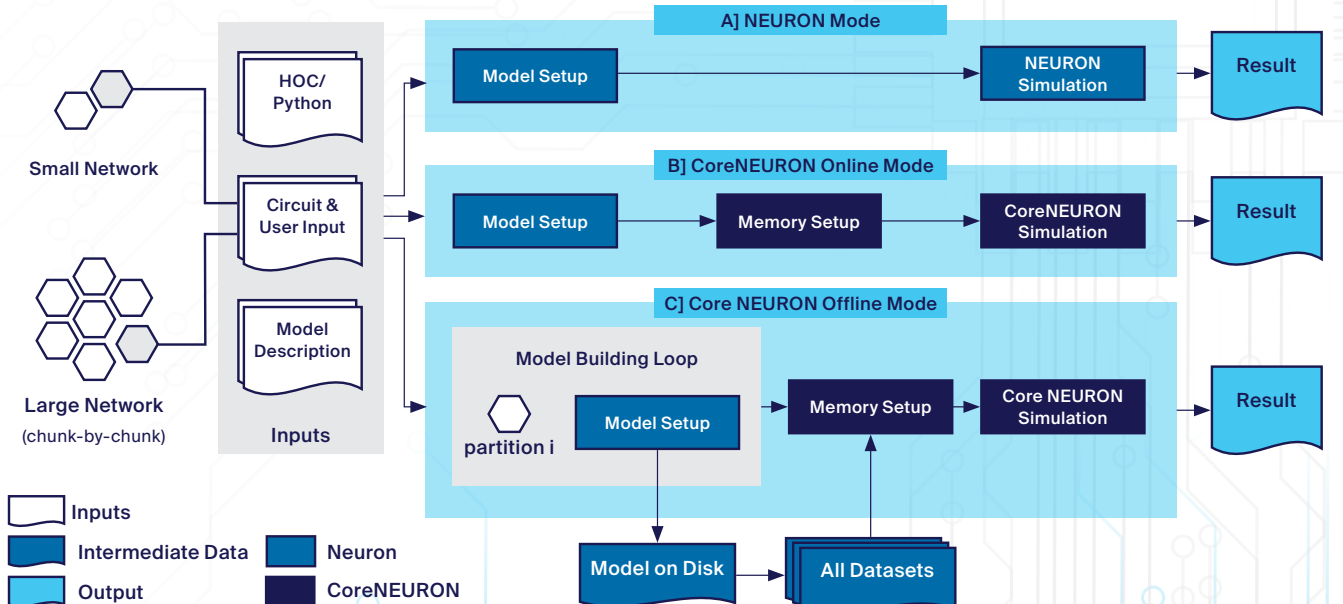
In order to improve performance and benefit from new computing architectures, the core functionalities of the widely used NEURON simulator have been isolated and optimized into a new simulator engine CoreNEURON. It helps existing NEURON users simulate larger models thanks to more efficient memory usage, reducing consumption to 15%-25% of the previous usage. In addition CoreNEURON yields faster simulation times of 2-7x speed up. CoreNEURON enables scientists to better utilize computing resources and helps deliver science sooner. CoreNEURON is developed by the Blue Brain Project in collaboration with Michael Hines at Yale University.

## The evolution of NEURON and the role of CoreNEURON



## Plasticity Simulation Workflow

To handle large network models that cannot be built at once, the CoreNEURON workflow loads data in pieces and optimized data is written to disk. Once all the pieces have been processed, CoreNEURON can load the cached data back from disk and run the full model using substantially less memory.

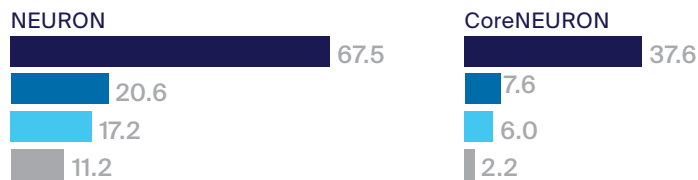


## Efficiency highlights of CoreNEURON

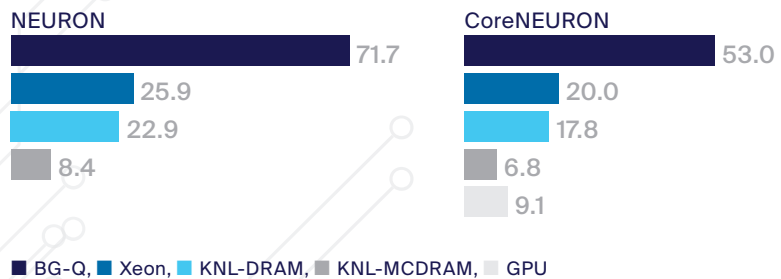
- Reduces memory requirement **up to 7x**
- Reduces time to simulation **by 2x to 6x**
- Supports existing NEURON models with **minimum porting efforts**
- Efficiently utilises new computing architectures like **Intel KNL**

CoreNEURON has been developed with the goal of minimizing memory footprint and maximizing scalability on large supercomputers. It supports graphics processing units (GPU), makes use of streamlined versions of data structures, and allows efficient use of compute hardware capabilities such as SIMD units on desktop as well as large supercomputing platforms. The memory usage is reduced by 7x and simulation time improved up to 6x. The CoreNEURON simulator handles spiking network simulations including gap junction coupling with the fixed time step method.

### Latest Simulation Time (seconds)



### Exemplar Ring Network Benchmark



## Software Adopters

**Giuseppe Chindemi**, a scientist within the Blue Brain Project is using CoreNEURON to create plasticity simulations on MIRA as part of an **INCITE grant**.

*“CoreNEURON opened a whole world of new possibilities for us. We can now study complex brain dynamics, such as connectome rewiring, at a level of detail that was impossible, not long ago.”*

**Oren Amsalem** who works in the Neurobiology department at the **Hebrew University of Jerusalem** uses CoreNEURON to simulate the somatosensory cortex with gap junctions.

*“CoreNEURON accelerated our simulations allowing us to replicate full length visual and auditory experiments. This enabled us to gain a deeper understanding of experimental results by uncovering the underlying biophysical and molecular mechanisms. CoreNEURON is extremely easy to use, the support team is responsive, helpful and friendly.”*

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## About EPFL's Blue Brain Project

The aim of the EPFL Blue Brain Project, a Swiss brain research initiative founded and directed by Professor Henry Markram, is to establish simulation neuroscience as a complementary approach alongside experimental, theoretical and clinical neuroscience to understanding the brain, by building the world's first biologically detailed digital reconstructions and simulations of the mouse brain.

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## CoreNEURON is available at:

As source: [github.com/BlueBrain/CoreNeuron](https://github.com/BlueBrain/CoreNeuron)

Installed in the Human Brain's Project Brain Simulation Platform:

[humanbrainproject.eu/en/brain-simulation/brain-simulation-platform/](https://humanbrainproject.eu/en/brain-simulation/brain-simulation-platform/)

In case of installing CoreNEURON from source, the user will also require NEURON for model building process: [neuron.yale.edu/neuron/](https://neuron.yale.edu/neuron/)

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## Acknowledgements

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