Parallel Computing of Local Field Potentials in Biological Neural Networks Using LFPy

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CRACOW GRID WORKSHOP 24-26.10.2016

Local Field Potential

- Local Field Potential (LFP) is an electric potential measured in extracellular space around neurons, within a small volume of nervous tissue.
- It is generated by the sum of electric currents flowing through multiple neurons near recording electrode.
- Due to the fact that the local field potentials from different neurons are additive in biological neural network – parallelisation of LFP estimating should improve the effectiveness of its computing.

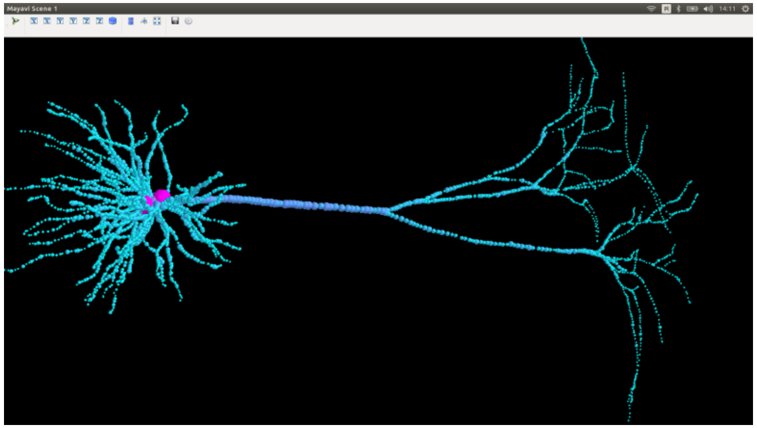
LFPy

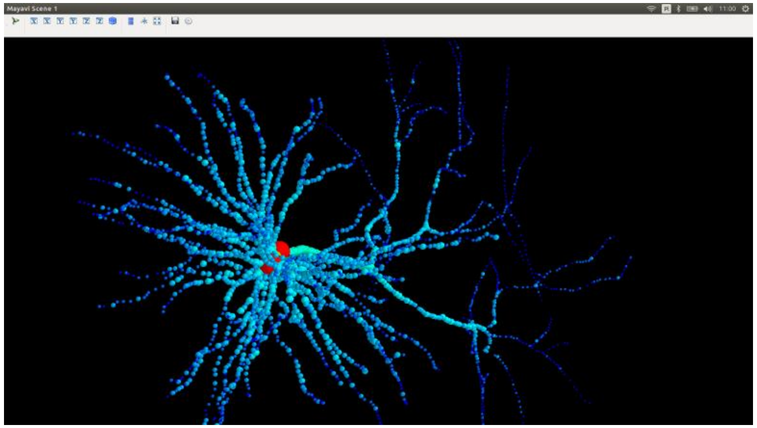
- LFPy is a Python package for calculation of extracellular potentials from multicompartment neuron models.
- It relies on the NEURON simulator and uses the Python interface it provides.
- K.H. Pettersen, H. Linden, A.M. Dale and G.T. Einevoll: Extracellular spikes and current-source density, in *Handbook of Neural Activity Measurement*, edited by R. Brette and A. Destexhe, Cambridge, to appear

Model and network

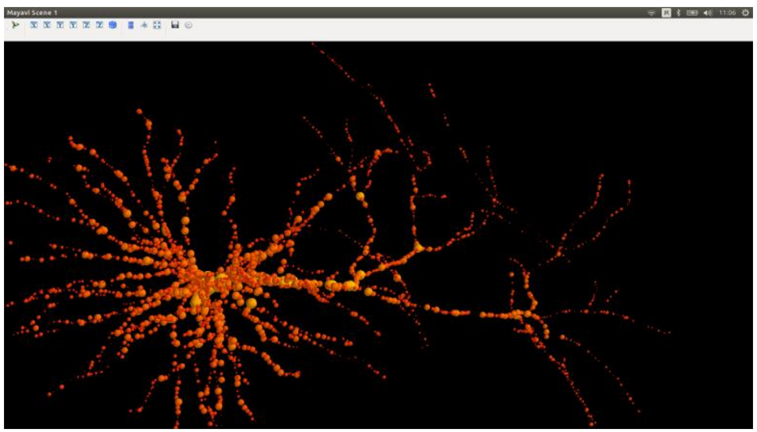
- Simulations of 64 and 100 neurons put on 8×8 and 10×10 grid using two types of processors.
- Neurons were modelled according to and were typical Hodgkin-Huxley neurons with the number of AMPA synapses ranging from 100-500.
- We use it to investigate the influence of temperature variations influence on synaptic dynamics of selected parts of the brain.

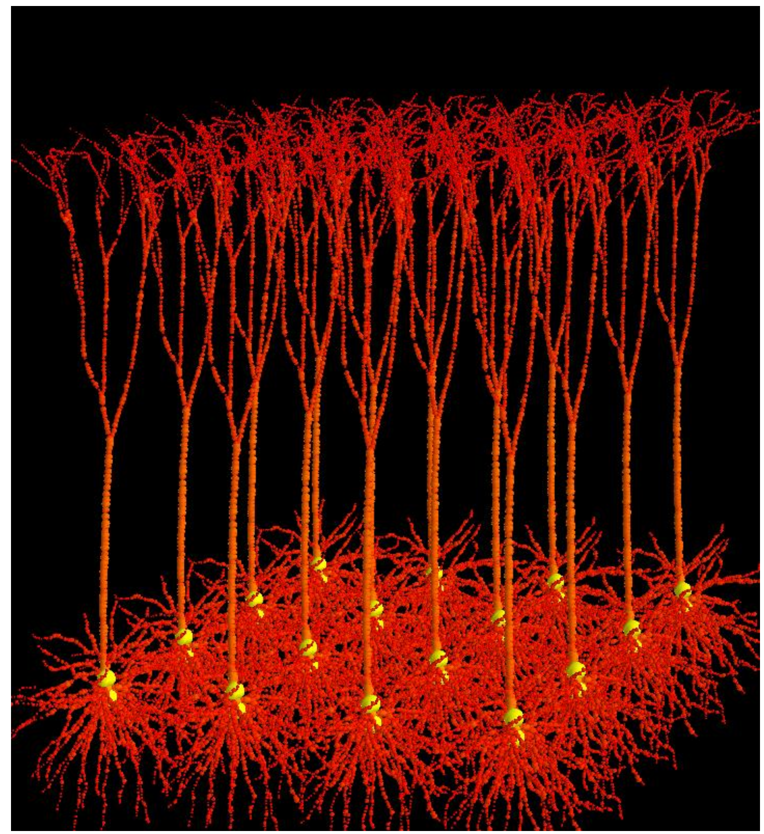
Cells modelled in Neuron





Cells modelled in Neuron





Paralellisation method

- Thanks to property of scalar addition of local field potentials one of the threads performs summation of all of the LFPs from other threads (using MPI), consequently leading to substantial increase of LFP computing speed.
- We used Ubuntu 16.04 based machines and MPICH version 3.2 (11 Nov 2015).

Time of simulations

	8×8	10×10
2×Intel(R) Xeon(R) CPU E5405 @ 2.00GHz, 8 GB RAM (8 cores)	**c.a. 420 s**	**c.a. 840 s**
Intel(R) Core(TM) i7-2670QM CPU @ 2.20GHz, 8 GB RAM (4 cores)	**c.a. 360 s**	**c.a. 660 s**

Summary

- Results presented in in Tab. 1 proved that as expected – the time of simulation increases with the complexity of the network. It also depends on the type of the processor used while having access to the same amount of memory.
- In real brains there are one hundred billion of neurons and each of them is on average connected with ten thousands of others. In the other hand the Local Field Potential has significant influence on physiological processes and simulation of 100 of cells is not what satisfies researchers.
- That is why in future work together with increasing the number of simulated cells we are going to run simulations on large architectures, i.e. using some available grid architecture.

References

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Acknowledgements

- Special thanks for Polish Children's Fund for valuable help in developing project.