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Parallel Software for Modelling Complex Nonlinear Dynamics in Large Neuronal Networks of the Brain

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Realistic simulation of collective neuronal activity is important for understanding brain functions, like memory mechanisms, neurological pathologies, etc. Such modeling requires taking into account large number of interacting neurons and implementation of complicated non-linear mathematical models of individual neurons like Hodgkin-Huxley equations. Synchronization of neuronal activity plays important role in functioning and pathology, but synchronization and bifurcation analysis for large number of neurons is a challenge for neuroscience community. Most popular software for neurons modeling (like Neuron, Genesis, etc) are interactive desktop tools that well suite for complicated neuronal models but in relatively small networks ($\sim$100 neurons). For large networks they are hardly usable.

In the present talk we introduce our software that specially designed for realistic modeling of large neuronal networks [1,2]. It is directed on computational and bifurcation study of Hodgkin-Huxley type networks. The main tasks are to estimate level of synchrony in the models, to choose principal parameters responsible for the nonlinear dynamics, and to find out how the collective rhytmes are affected by external signals and possible stimulations.

[1] R.I. Levchenko, O.O. Sudakov, and Yu.L. Maistrenko *Proc. NDES 2009*, Rapperswille, Switzerland, p. 34-37.

[2] R.I. Levchenko, O.O. Sudakov, S.D. Pogorilyy *Proc. IEEE International Workshop on Intelligent Data Acquisition and Advanced Computing Systems*, 2009, Rende (Cosenza), Italy . p. 208-211.