Computational Neuros

Monday, July 8, 2013

[Comp-neuro] Postdoctoral position in Neuronal Reaction-Diffusion Simulation

A postdoctoral fellowship is available as part of an ongoing project to add Reaction-Diffusion simulation to the widely-used NEURON simulator (www.neuron.yale.edu). Although this postdoctoral experience will be highly technical, the context is biology and we ensure that all of our advances are published and accessible for dissemination to a biological audience -- ie there is ample opportunity for authorship.

Candidates should have a strong background in computer programming, with demonstrated fluency in C/C++ or Python or some other major programming language, ideally with a substantial software project to show for it. Familiarity with cell biology, neurobiology or chemistry simulation is a plus. Familiarity with Unix is important. Numerical integration, MPI/HPC, version control (we use hg) nice too.

This position offers an opportunity to develop novel software tools that will be widely used by the research community. The postdoc will receive training in a wide range of interdisciplinary skills from computer science, applied math, biophysics, cell biology, electrophysiology, etc. The work is being performed in close collaboration with experimental laboratories, giving the opportunity to immediately determine how closely a modeling technique can match the experimental reality (or in rare cases, how adequately experimental artifact can be reduced so as to match models). The work is being done under the auspices of the National Institute of Mental Health and has substantial clinical translational potential for making linkages between genomics, proteomics, pharmacotherapy and neuronal/network outcomes for psychiatric and neurological disorders. The NIH and other agencies (FDA,NASA,NSF,DARPA,others) have a strong interest in this multiscale modeling approach, sponsoring an annual meeting for which the laboratory has taken major initiatives.

Further details: This project offers a number of interfacing and development challenges. 1. Ion concentrations at the surface determine driving forces for channels, calculated as a Nernst potential or via Goldman-Hodgkin-Katz equations. These surface-layer concentrations must be in placed into equilibrium with diffusing ion concentrations within cytoplasm. 2. Potential gradients also arise across internal membranes. It has been hypothesized that the endoplasmic reticulum

(ER) exists as a "neuron within the neuron" that signals both via electrical and calcium signaling. 3. One cannot simply handle the whole neuron as 1 big diffusion problem: neurons are too big and have different cytoplasmic domains that require different types of simulation: stochastic 3D for spines, deterministic 1D for major dendrites, deterministic 3D for soma. This requires developing a number of simulators within the simulator and interfacing all of them properly. 4. Standard neural tracings, which are quite adequate for electrical simulation, lack the detail required to produce watertight volumes for reaction-diffusion modeling -- we are developing algorithms to map the approximate full surface and instrument both surfaces and the enclosed volumes. 5. Reaction schemes can be extremely complex, yet often lacking in the kinetic parameters that would be needed to produce an accurate ODE representation. Therefore instead of using full kinetic descriptions we may need to use highly simplified Boolean networks (BNs) or other rule-based representations. These representations must then be interfaced with kinetic representations and with diffusion mechanisms.

Applicants should contact Bill Lytton by email (billl at neurosim.downstate.edu; no snail please) with a CV and cover letter. SUNY is an equal opportunity employer.

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