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The Blue Brain Project - Simulation-based Research in Neuroscience

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The initial phase of the Blue Brain Project aims to reconstruct the detailed cellular structure and function of the neocortical column (NCC) of the young rat. As a collaboration between the Brain Mind Institute of the Ecole Polytechnique Federale de Lausanne (EPFL) and IBM the project is based on the many years of experimental data from an electrophysiology lab and a dedicated massively parallel computing resource (4-rack BlueGene/L). Over the last 3 years an interdisciplinary team of 35 researchers has cast the reverse-engineering of the biological pieces and the forward construction of detailed mathematical models in an iterative process that allows continuous refinement. Particular efforts go into the preparation of 10,000 unique morphologically-complex electrical models representing all morpho-electrical classes as well as establishing their structural and functional connectivity. Once a multi-compartmental description for each neuron is generated and the exact locations of the synapses (~30 million) are determined, the simulation is supposed to reproduce emergent properties found in slice experiments. The refinement is directed by a bottom-up calibration that aligns the model across all levels - from the ion channels to the emergent network phenomena - with the experimental data. In order to put the expert in the loop, extensive use of visualization and interactive analysis is made, which is powered by another dedicated supercomputer in order to realize short turn-around times.

Summary

The initial phase of the Blue Brain Project aims to reconstruct the detailed cellular structure and function of the neocortical column (NCC) of the young rat. As a collaboration between the Brain Mind Institute of the Ecole Polytechnique Federale de Lausanne (EPFL) and IBM the project is based on the many years of experimental data from an electrophysiology lab and a dedicated massively parallel computing resource (4-rack BlueGene/L). Over the last 3 years an interdisciplinary team of 35 researchers has cast the reverse-engineering of the biological pieces and the forward construction of detailed mathematical models in an iterative process that allows continuous refinement. Particular efforts go into the preparation of 10,000 unique morphologically-complex electrical models representing all morpho-electrical classes as well as establishing their structural and functional connectivity. Once a multi-compartmental description for each neuron is generated and the exact locations of the synapses (~30 million) are determined, the simulation is supposed to reproduce emergent properties found in slice experiments. The refinement is directed by a bottom-up calibration that aligns the model across all levels - from the ion channels to the emergent network phenomena - with the experimental data. In order to put the expert in the loop, extensive use of visualization and interactive analysis is made, which is powered by another dedicated supercomputer in order to realize short turn-around times.

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