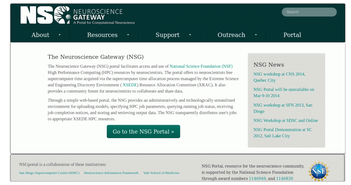
Neuroscience Gateway – Understanding the scaling behavior of NEURON application

S. Sivagnanam[1], A. Majumdar[1], P. Kumbhar[2], M. Hines[3], K. Yoshimoto[1], T. Carnevale[3]
[1]San Diego Supercomputer Center;[2]Ecole Polytechnique Fédérale de Lausanne [3]Yale University School of Medicine
http://www.nsgportal.org
Contact: nsghelp@sdsc.edu



The **Neuroscience Gateway (NSG)** (in operation since 2013) allows neuroscientists to easily use High Performance Computing (HPC) resources for computationally intensive modeling tasks such as simulating large-scale networks, creating functional and structural connectomes, exploring high-dimensional parameter spaces etc. The NSG reduces entry barrier to use HPC by streamlining administrative procedures and providing a convenient web browser-based interface. **NSG REST (NSG-R**) interface allows programmatic access to HPC from neuroscience community projects and advanced users.

Benefits

NSG benefits the broader neuroscience research community in several ways, e.g.:

•Researchers can run larger complex neuronal networks, parameter sweep simulations, brain image processing tools

•Fully integrated The Virtual Brain (TVB) connectome pipeline workloads can be processed in parallel

•Easy access to widely used simulation tools such as:
Brian, NEST, NEURON, pGENESIS, PyNN, MOOSE, TVB and FreeSurfer

•Researchers from EU Human Brain Project providing optimization pipeline

•Access to new HPC resources – GPUs, Intel MICs

•Can be used by researchers with limited local (university-level) resources to address questions that require access to large scale, advanced systems

•Can be used by simulator developers to test, benchmark, and scale codes on large scale resources

•Can be used for classes, workshops, and tutorials

Key Accomplishments to Date

•NSG users used in the three and half years, millions of SUs on SDSC's Trestles, Comet and TACC's Stampede supercomputers

•Around **350** registered researchers since early 2013

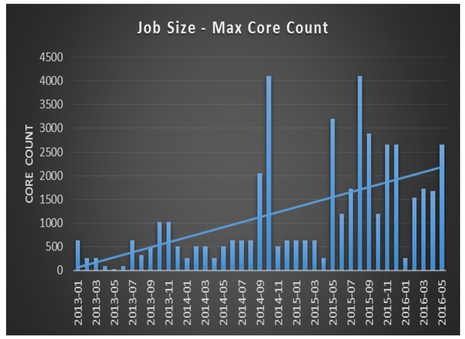
•Around 150 researchers attended 5 NSG workshops held at Society for Neuroscience (SFN), Computational Neuroscience meeting (CNS) and XSEDE workshops in the past two years

•High school students internship (two in 2013, three in 2014, two in 2015, two in 2016), UCSD undergrad (one in 2013)
•NIH sponsored MSI visit & NSG workshop at New Mexico State University, Mar 2015; NIH sponsored workshop at U. Missouri; NSF/NIH/Janelia NEURON workshop

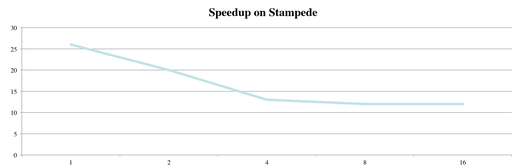
Cite NSG as Follows

S. Sivagnanam, A. Majumdar, K. Yoshimoto, N. T. Carnevale, V. Astakhov, A. Bandrowski, M. Martone, "Introducing The Neuroscience Gateway," Proceedings International Workshop on Science Gateways , Zurich, Switzerland, June 3-5, 2013.

Usage characteristics

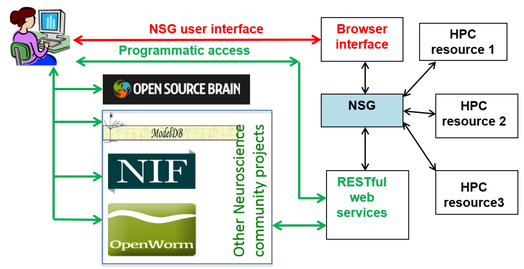


NEURON performance work :



Programmatic Access through REST services

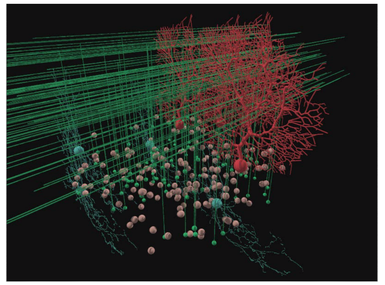
Provide programmatic access through REST services that will allow users of neuroscience community projects (OSB, NIF, ModelDB) to readily access and run simulations on HPC resources. Experienced model developers will be able to run their models directly on HPC from the familiar software environment within their laptop or desktop.



Acknowledgement (NSG grants)

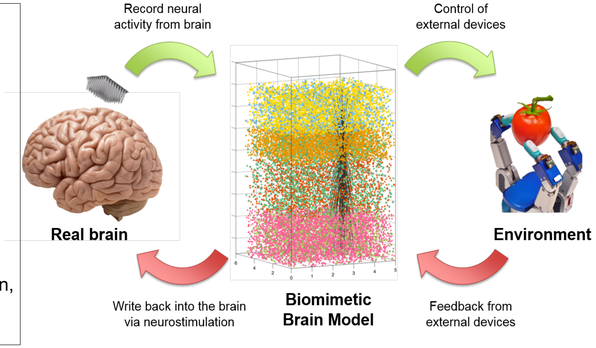
DBI 1458840 (PI Majumdar, Co-PI Sivagnanam, UCSD), DBI 1458495 (Co-PI Carnevale, Yale), DBI 1146949 (PI Majumdar, Co-PI. Martone, UCSD), DBI 1146830 (Co-PI Carnevale, Yale); SDSC Internal grant (PI Sivagnanam); NINDS NS11613 PI M. Hines, the Blue Brain Project

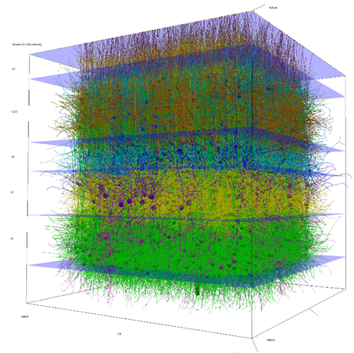
Some Example Science Simulations Enabled by NSG



Visualization of 3-D Cerebellar Cortex model generated by researchers Angus Silver and Padraig Gleeson from University College London;
NSG was used for simulation.

- Integration of a simulation with dynamically assimilated data
- Multiscale modeling and computation
- Tw0-way interaction between model execution and data acquisition
- S. Dura-Bernal, S. Neymotin, J. T. Francis, W. W. Lytton, SUNY Downstate Medical Center





- *Neural activity is recorded via extracellular probes inserted into neural tissues; individual spikes can be isolated from such data*
- *Allen Institute of Brain Science researchers are simulating extracellular recording using tens of thousands of detailed cells*
- *Using the NEURON simulation tool via the NSG*
- *Require ~30,000 core hours per data set*

Simulation run on the NSG for a 55,000 mouse cell column using 30 nodes (720 cores) for 25 hours.
Research and *Image credit Mitelut, Gratiy, Spacek, Anastassiou and the Allen Institute for Brain Science*