The HBP Calls for Expression of Interest for SGA3 "Preparing Cellular-Level Models for Portable HPC Simulation using Arbor"

Call Text

Project Number:	785907	Project Title:	Human Brain Project SGA2

Document Title:	HBP CEoI for SGA3 - Preparing Cellular-Level Models for Portable HPC Simulation using Arbor – Call Text
Document Filename:	HBP_SGA2_CEoI_Arbor_Call_Text
Dissemination Level:	PU = Public
Abstract:	Calls for Expression of Interest for SGA3, Call Text
Keywords:	cellular-level models, high-performance computing, Arbor, simulation engine
Target Users/Readers:	Applicants, all interested
Call Publication Date:	04.10.2019
Pre-proposal Submission Deadline:	06.11.2019 17:00 Brussels time
Proposal Submission Deadline:	04.12.2019 17:00 Brussels time
Proposal submission online platform	HBP Open Call Platform
Total Call Budget:	EUR 900,000. Maximum funding per proposal: EUR 450,000
More information:	info@opencalls.humanbrainproject.eu

This Call for Expressions of Interest (CEoI) is for organisations interested in preparing cellular-level models for portable high-performance computing (HPC) simulation using Arbor.

Expert computational neuroscientists from both outside and inside the HBP are invited to develop models and adapt workflows for Arbor, specifically for networks of detailed cell models that require HPC. Fostering support for Arbor in the EBRAINS ecosystem will enable open, efficient and portable simulations of cellular-level models across a variety of current and emerging supercomputing resources.

1. Challenge

Open development of software tools and support for open standards are core objectives for software tools, workflows and data sources on the EBRAINS infrastructure in order to tackle new neuroscience challenges such as simulating entire brain regions, multiscaling multiple brain regions, attacking learning and circuit optimisation over long periods, or handling the inverse problem in quantifying cell characteristics and network features. Two key approaches to addressing this challenge inside the HBP are: first, the development of the open simulation engine Arbor; and second, the adoption of simulator- and platform-agnostic model interchange formats.

Arbor has been developed internally in the HBP to address this challenge. Arbor [1, 2] is a performance-portable simulation engine for cellular-level models, with transformative improvements in time to solution and memory consumption compared to existing simulation engines, using open and platform-neutral data exchange standards. Arbor will have a transformative impact if adopted, enabling the use of all HPC systems in the HBP, as well as future emerging technologies, such as those provided through EuroHPC. However, its adoption requires integration into appropriate existing and new HBP workflows, and commitment from early movers in the user community to porting and tuning models.

In SGA3, modelling activities will focus on porting models and workflows to use platform-agnostic interchange formats such as the SONATA model description format. SONATA aims to be open and simulator-agnostic; however, currently it only supports the NEURON simulation engine for simulations at the cellular level and allows non-portable NEURON-specific file formats. To properly support open standards, it is imperative to further develop such formats for real use cases using multiple simulators. Arbor has prototype SONATA support that will be close to feature-complete at the beginning of SGA3, excepting extensions closely tied to NEURON implementation details.

2. Details

This CEoI is addressed to organisations focused on simulation of network models of morphologically-detailed cells that rely on high-performance computing. Examples of such models include:

- Large network models that require significant simultaneous supercomputing resources including CPUs, GPUs and future accelerators.
- Ensembles of many smaller, or long running, models.
- Multiscale and embedded networks requiring in-transit data interchange between heterogeneous components, including spikes, voltages, currents and other continuous large-scale data.

In each case, significant parallel computational resources, as well as integration into modular software infrastructure and workflows for supercomputing are required.

These computational objectives will enable access to emerging challenging domains of neuroscientific research, including as examples (but explicitly not exhausting!):

- Large networks within this time frame may reach up to 10^7 neurons, enabling computationally efficient simulations of significant brain regions at full resolution. Coupling these in a multiscale fashion would allow the simulation of multi-region circuits at various characteristic resolutions.

- Long running models are needed for investigating theoretical models of structural plasticity, and learning, as well as comparing the optimisation of neuronal processing circuits to variously experimentally imaged and measured circuits.
- Large ensembles of networks can be used to handle inverse problems through large-scale parameter sweeps: comparing experimentally accessible values (such as LFP results) to ion channel characteristics, network topologies, or synaptic parameters and distributions.
- By embedding simulations inside software systems, software tools can be constructed requiring detailed in-transit data transported at scale, such as very large-scale LFP prediction and analysis or multi-physics simulations.

The objectives of this CEoI are to:

- Encourage the adoption of open standards in the computational neuroscience community in Europe.
- Increase the target audience of the cellular-level simulation facilities of the HBP simulation platform.
- Validate and improve the HBP-developed simulation technology Arbor.

These objectives will be achieved by porting existing models and workflows designed for NEURON to a simulator agnostic description, and validating their portability using the Arbor simulation engine. Such validation will require commitment from interested parties to update workflows and model descriptions, support from the Arbor developers to add features, and HPC resources for the jointly implemented simulations. Thus, the integration of Arbor aims to achieve both transformative simulation performance and improved support for open standards and development for simulation services on the EBRAINs platform.

Specifically, this CEoI will enable:

- Adaptation of models and workflows so that simulator-specific components are isolated rather than pervasive.
- Writing Arbor-specific parts of these models and workflows.
- Co-development with the Arbor team of required features.

In particular, the selected proposals will address the following points:

- Explain the model and workflow, and why it is relevant for HPC.
- Describe scientific outcomes that would will be specifically enabled by using state-of-the-art HPC simulation.
- Describe how the models and required datasets will be publicly released.
- Describe how the results of simulation ported to a new model description will be validated against existing results.
- Describe concrete objectives and results to be achieved in the 30-month time frame.
- Describe the Milestones and the Tasks required to achieve the objectives.

References

1) N. A. Akar, B. Cumming, V. Karakasis, A. Küsters, W. Klijn, A. Peyser, and S. Yates. Arbor — A Morphologically-Detailed Neural Network Simulation Library for Contemporary High-Performance Computing Architectures. pages 274–282. 2019 27th Euromicro International Conference on Parallel, Distributed and Network-Based Processing (PDP), Pavia (Italy), 13 Feb 2019 - 15 Feb 2019, IEEE, Feb 2019. ISBN 978-1-7281-1644-0. doi:10.1109/EMPDP.2019.8671560.

2) N. A. Akar, J. Biddiscombe, B. Cumming, F. Huber, M. Kabic, V. Karakasis, W. Klijn, A. Küsters, A. Peyser, and S. Yates. arbor-sim/arbor: Arbor Library v0.2, 4 Mar. 2019. doi:10.5281/zenodo.2583709.