Multi-scale brain co-simulation in the Human Brain Project: EBRAINS tools for in-transit simulation and analysis

Muhamad Fahad[1], Kim Sontheimer[1], Cristian Jimenez-Romero[1], Rolando Ingles Chavez[1], Sandra Diaz[1], Wouter Klijn[1], Abigail Morrison[1,2,3]

[1]Forschungszentrum Jülich GmbH, Institute for Advanced Simulation, Jülich Supercomputing Centre (JSC), Simulation & Data Lab Neuroscience, JARA, 52425 Jülich | Germany
[2]Forschungszentrum Jülich, GmbH, Institute of Neuroscience and Medicine (INM-6) and Institute for Advanced Simulation (IAS-6), 52425 Jülich | Germany
[3]Software Engineering, Department of Computer Science 3, RWTH Aachen University, Ahornstraße 55, 52074 Aachen | Germany

Email: m.fahad@fz-juelich.de

An important capability build by The Human Brain Project (HBP) is brain simulations of large- and multiscale experimental and clinical data sets with integrated analysis toolkits. This results in workflows with multiple components to be run in parallel and in coordination with each. How to develop an end-user friendly production system capable of running these workflows is an open question, and introduces several scientific, engineering, and execution challenges: Parallel execution in a distributed environment. Data-flow and transformation between different scales, as well as error propagation related to the model complexity. Tolerance to network isolation/failure, the identification of communication/computation bottlenecks, and the growing probability of the fault condition as a multiplicative function of the number of applications in a workflow and their individual failure probabilities.

To address these challenges, the multi-scale co-simulation framework, based on the Modular Science approach [1], connects at runtime the needed simulation engines, analysis tools and visualization engines. The Modular Science runtime execution system augments the science functionality with engineering and deployment functionality providing a handle on the complexity of the system.

This talk will introduce the multi-scale co-simulation framework and the Modular Science approach to address the challenges with a focus on two-driving use-cases containing a NEST model. Firstly, a TVB[2] and NEST co-simulation with dedicated transformation modules connecting a spiking network with a neural mass model. The second use-case is a co-simulation setup connecting NEST to the multi-agent simulation environment NetLogo[3], where a small point neuron network simulation controls agents interacting in a simple world.

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