Visual exploration and generation of connectivity in neural networks

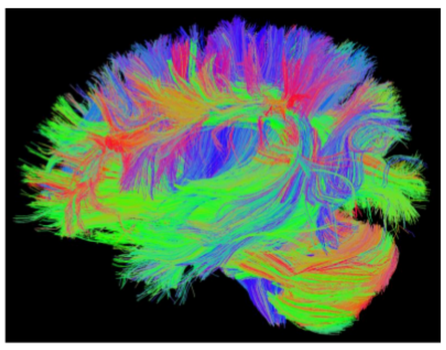
bridging the gap between empirical data and theoretical model definition.

Patrick Herbers[a,b], *Sergio E. Galindo[c], *Wouter Klijn[a], Sandra Diaz-Pier[a], Juan Pedro Brito[d], Pablo Toharia[d], Susana Mata[c,d], Oscar D. Robles[c,d], Luis Pastor[c,d], Juan J. Garcia-Cantero[c], Alexander Peyser[a]

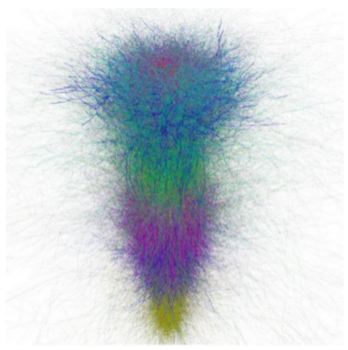
[a]Simulation Lab Neuroscience, Bernstein Facility for Simulation and Database Technology, Institute for Advanced Simulation, Jülich Aachen Research Alliance Forschungszentrum Jülich
[b]MRG Structure Of Memory, Ruhr-Universität Bochum, Bochum, Germany [c]Universidad Rey Juan Carlos, Madrid, Spain [d]Center for Computational Simulation, Universidad Politécnica de Madrid, Madrid, Spain

Co-funded by the European Union

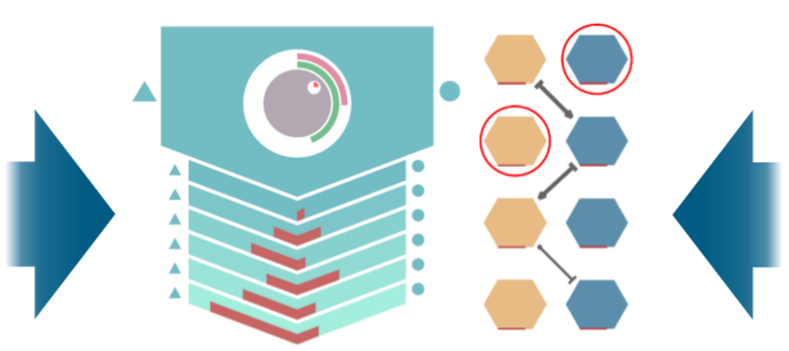
Connectivity from empirical data and theoretical model definition



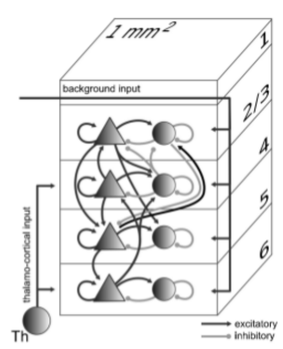
MRI derived diffusion tensor tractography (Caspers *et al*. 2014).



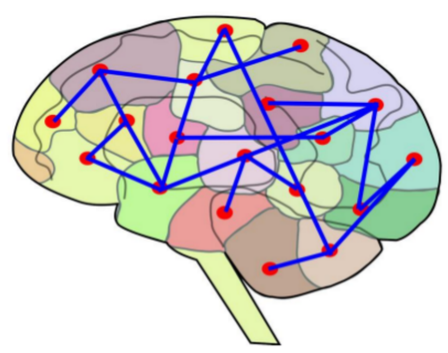
3D representation of dendritic trees in a cortical microcolumn (Pastor *et. al.* 2015, Data: Blue Brain Project).



Two abstract representations of a cortical micro-column in NeuroScheme. Left: derived from experimental data; right: from an explicit model description (Pastor *et. al.* 2015).



Four layer 8 population model of a micro column (Potjans *et. al.* 2011).



Whole brain connectivity graph based on neuronal mass models (Woodman, *et al.* 2017*)*.

NeuroScheme

A set of tools and representations that allow the mapping of information onto visual representations in a graphical user interface (Pastor *et. al*. 2015).

NeuroML

XML based language for describing neural morphology, neurophysiology and networks. Allows interchange between different simulators and tools (Gleeson, *et. al*. 2010)

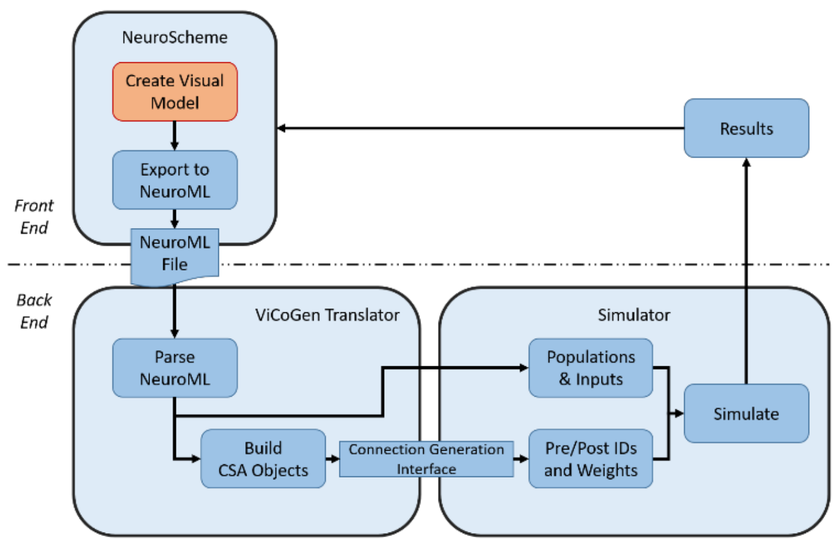
Translator

A simulator agnostic link between visualization, description and simulation.
Translates NeuroML files into CSA for connectivity generation.

Empirically derived data and theoretical models expressed in a shared visual representation called NeuroScheme

NeuroScheme can generate connections for simulation or further processing

Simulator independent and open source interfaces



Flowchart 1: Visual connection generation: The scientist interacts with a visual representation of the model (red box). Via application independent open source interfaces the model can now be simulated.

Connection Set Algebra (CSA)

Algebraic-set-based language describing connections. Operations, modifiers and ranges allow description of connectomes on all levels of abstraction (Djurfeldt, 2012)

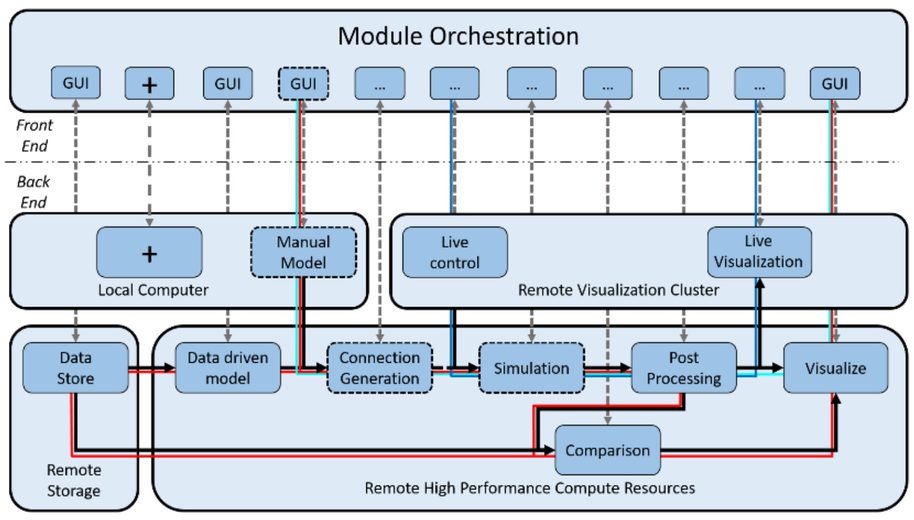
Connection Generation Interface

Application Programming Interface (API) prescribing how a simulator receives connections generated on the basis of a CSA description (Djurfeldt, 2014)

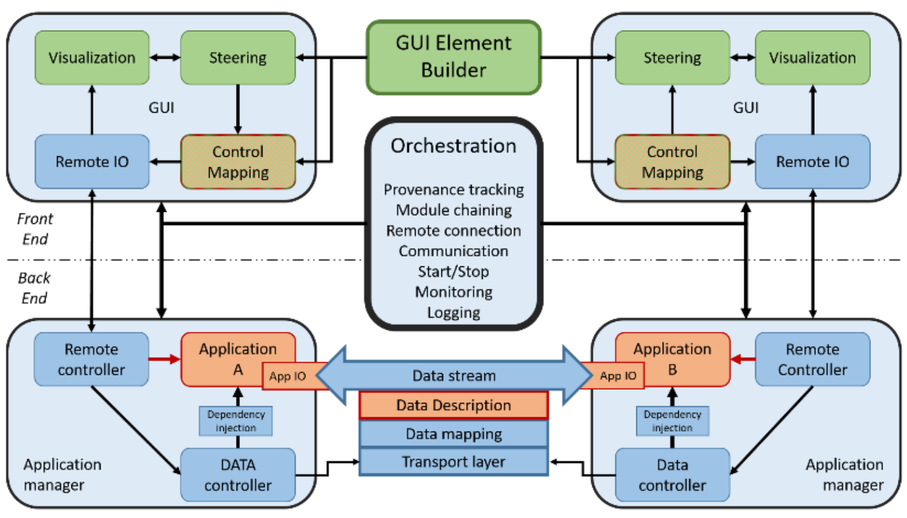
Simulator

Usage of Open Source and public APIs allows easy integration in existing tools. Current proof of concept integrates with NEST (Kunkel, 2017)

Bridging the gap between empirical data and theoretical model definition?



Flowchart 2: High-level overview of our proposed integration of multiple workflows using shared interfaces and modular components. We envision a strict separation between user interactions in GUIs at the front-end and system level resources (back-end). Blue line: live / in-situ steering of a running simulation. Cyan, offline connection simulation and visualization of networks. Red, comparative workflow between experimental data and simulated results. The bold boxes are further detailed in Flowchart 1.



Flowchart 3: Overview of the detailed interactions between two modular applications, and the front- and back-end. The boxes in green represent an interactive GUI builder. It will produce GUI elements that integrate with the framework components in blue. The red boxes denote domain specific (typically currently existing) software. The creation of technical APIs and functional rules eases the integration of existing components into this modular science tool.

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Reference and Further Information

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Acknowledgements

The European Union's Horizon 2020 Programme under grant no. 720270 (HBP SGA1)
The Spanish Ministry of Economy and Competitiveness under grants C080020-09 and TIN2014-57481
JARA-HPC, the Helmholtz Association through the Portfolio Theme SMHB and the CRCNS grant.

w.klijn@fz-juelich.de

sergio.galindo@urjc.es