SIMLAB NEUROSCIENCE: SUPPORTING NEUROSCIENCE WITH HPC

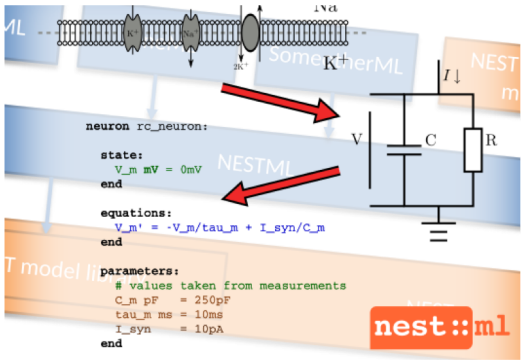
04.10.2018 I Prof. Abigail Morrison

Mitglied der Helmholtz-Gemeinschaft

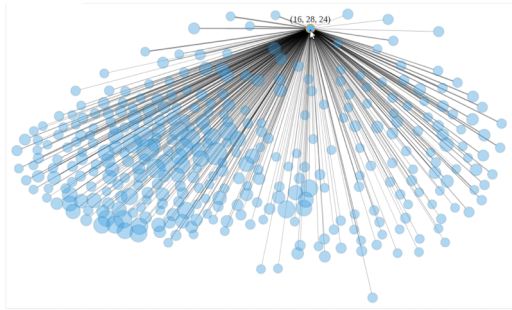
JÜLICH
Forschungszentrum

AREAS OF RESEARCH & COLLABORATION

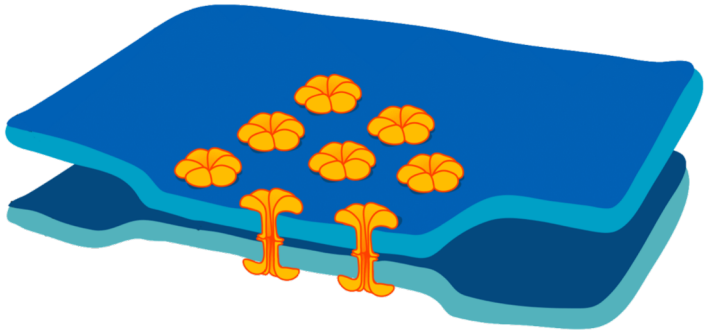
- Simulation Engineering



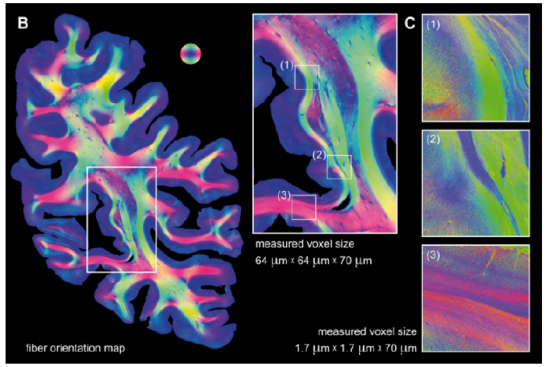
- Analysis and Visualization



- Simulation Science



- Neuroimaging Pipeline

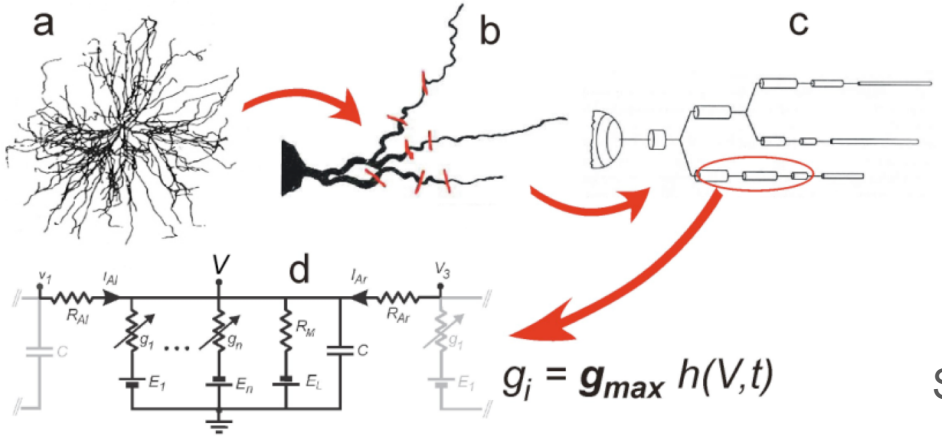


SLNS RESEARCH CONTRIBUTIONS TO

- Arbor
  CSCS, BSC, Palermo, Yale
- NEST
  INM-6, NMBU, BU-Wuppertal
- The Virtual Brain
  INM-7, Charité, U Indiana, CNRS, Aix-Marseille
- Interactive Steering & Visualisation
  RWTH
- JUPex
  U Graz
- Modular science workflow
- ICEI – Fenix
  - Benchmarking
  - Use cases

ARBOR

(WP 7.4)



Smith et al., (2007)

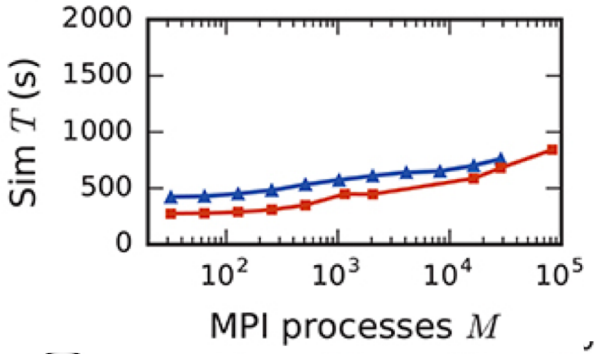
- Simulator for networks of morphologically detailed neurons
- Optimized for heterogeneous many-core hardware
  - Modern C++ and CUDA
  - Optimized backends: CUDA, KNL and AVX2

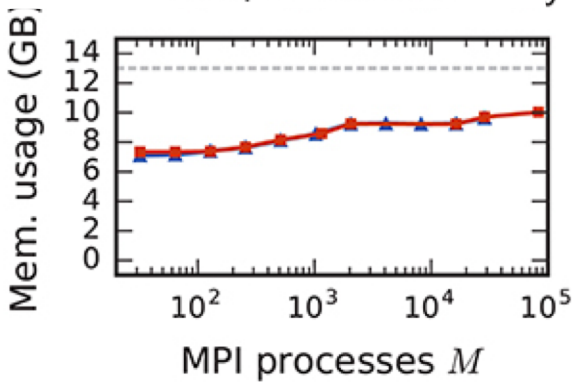
- Modern development practices:
  - Open-source and open-development
  - Unit-testing, continuous integration and validation

NEST

(WP7.4)

- Simulator for large networks of spiking point neurons
- Optimized for homogeneous large-scale architectures, but scalable down to small clusters and laptops





Jordan et al., (2018)

- largest general network simulation performed to date:
- 1.86×10^9 neurons, 6000 synapses per neuron
- 1.08×10^9 neurons, 6000 synapses per neuron

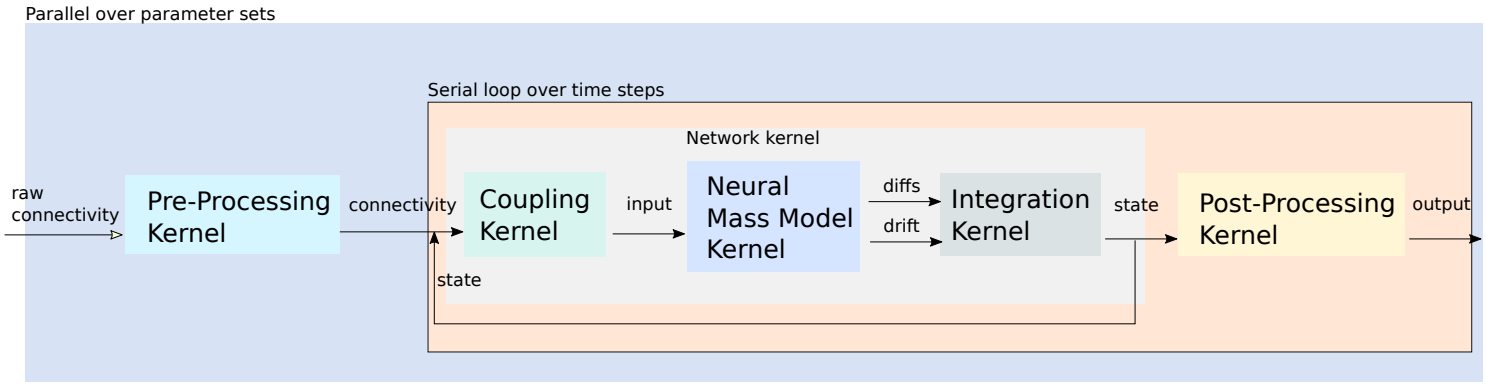
NEST

(WP7.4)

- Long standing collaboration with INM-6 and NMBU
  - Contributors spread all over Europe
- Regular software releases, citable via zenodo to enhance reproducibility
- SimLab foci:
  - Next generation kernel
  - HPC-amenable IO
  - DSL to generate neuron (synapse) models from high level description
  - Structural plasticity
  - Interactive steering capability
  - Visual connectivity generation
  - Verification of neuromorphic computing platforms

THE VIRTUAL BRAIN

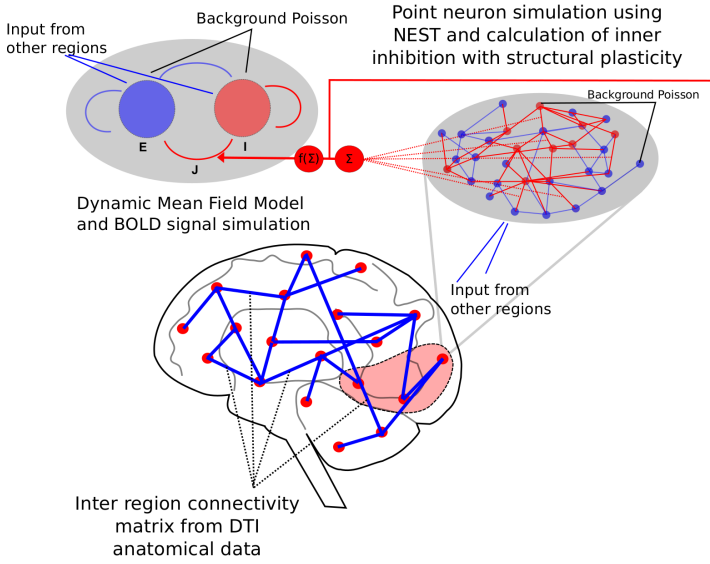
(WP7.3)

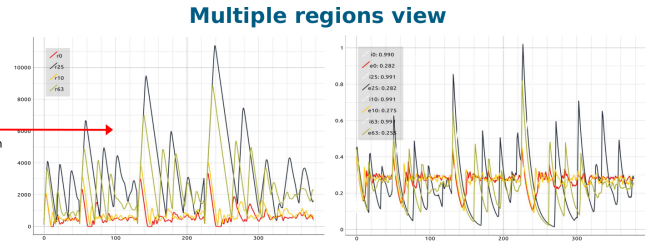


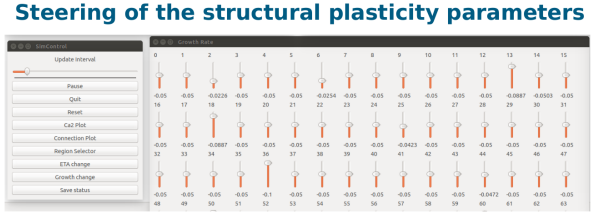
- Simulator for whole brain neural mass models
- SimLab foci:
  - Flexible HPC kernel design allowing deployment on a variety of parallel architectures (GPUs, FPGAs) and specialized processors (KNC, KNL)
  - Interface between TVB front-end and highly optimized model specific kernels
  - Development of a DSL for automatic generation of neural mass models
  - Performance enhancement of TVB simulation and analysis tools

INTERACTIVE STEERING & VISUALISATION

(WP7.3)





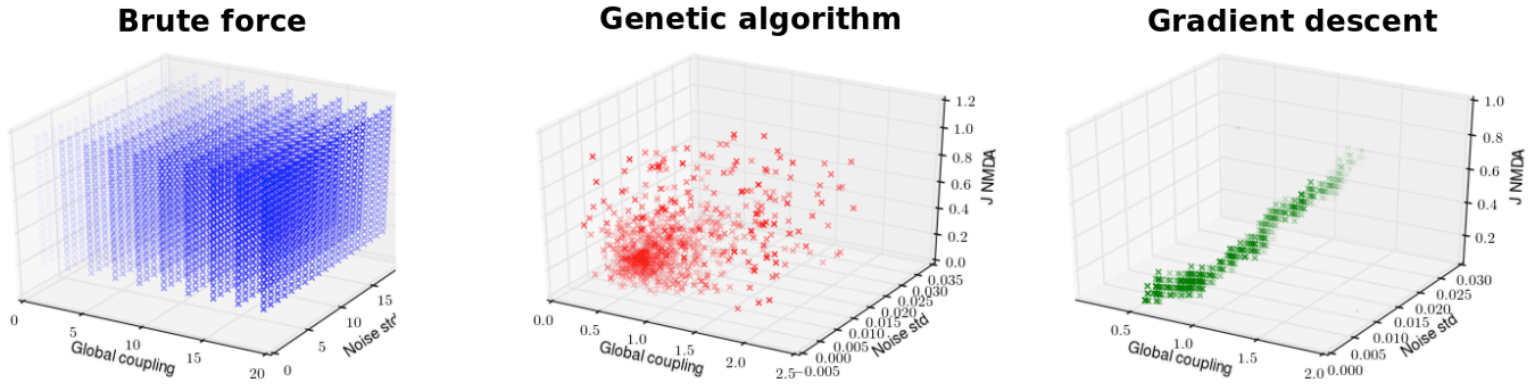


(Nowke et. al. 2018)

- Tool based on `nett` software framework developed at RWTH Aachen
- Facilitates interactions with NEST simulations during run time:
  - Change parameters, visualize effects
  - Visually guided parameter exploration
  - E.g. to find connectivity parameters for TVB models

JUPEX

(WP7.3 & WP9.4)

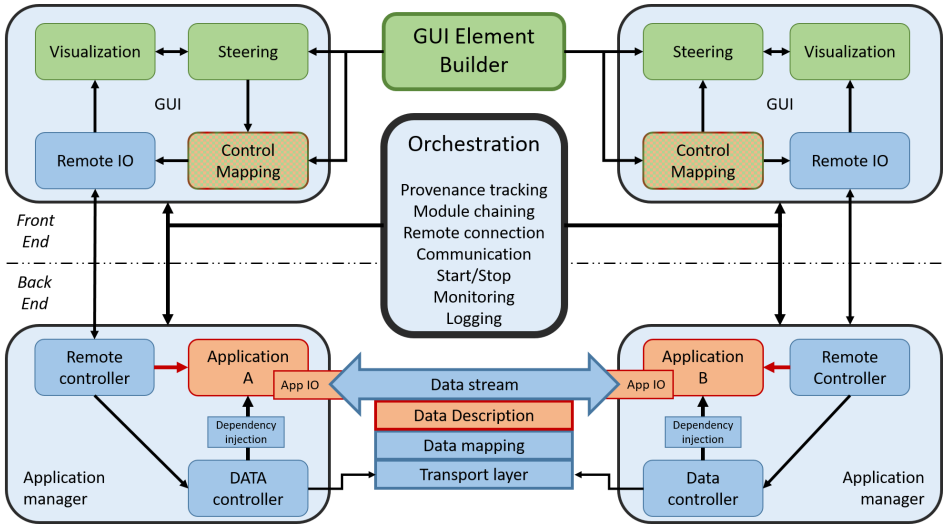


(Diaz-Pier et. al. 2017)

- Addresses the problem of parameter space exploration and optimization for large scale complex simulations on HPC systems
- Extends the UNICORE and JUBE frameworks developed in the JSC to provide a flexible platform for parameter exploration using well known optimization algorithms

MODULAR SCIENCE

(WP7.1.2)



- Orchestration of scientific applications to deploy complex workflows on HPC systems
  - APIs for the communication of data between different applications
  - Wrapper software to allow deployment and monitoring of these applications on hybrid HPC resources
  - Interactive visualization front end to define workflows and explore results

SIMLAB NEUROSCIENCE

Bridging Neuroscience & HPC