Using structural plasticity to study the relationship between structure and function in the brain

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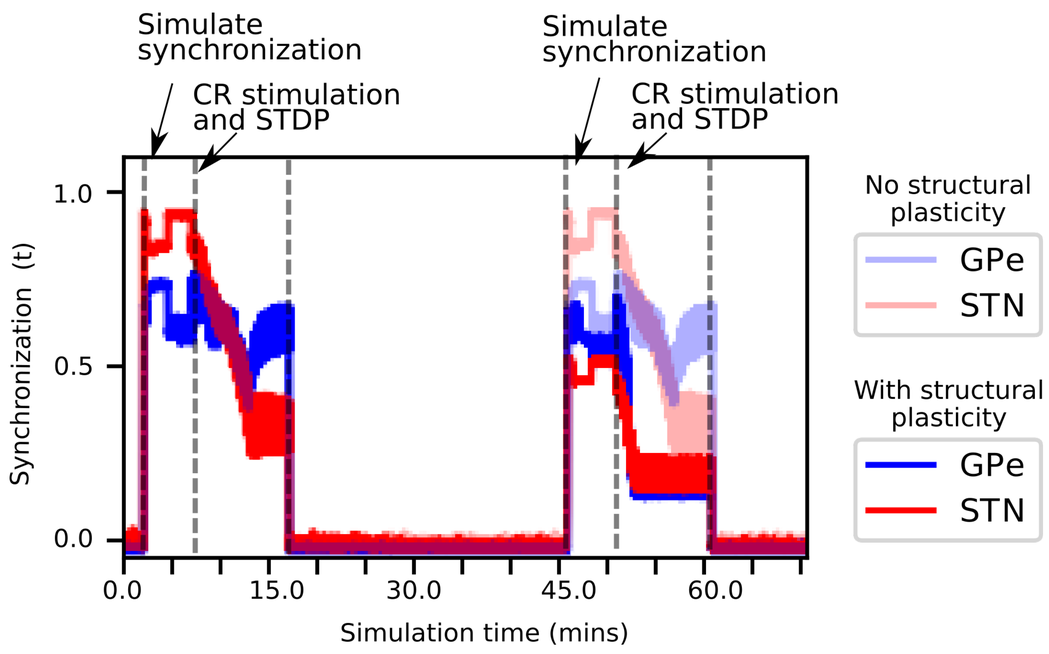
Motivation: We want to better understand the impact that changes in connectivity have on brain function at different scales.

Our approach: Use structural plasticity in nest::

Neurobiological modelling of **structural plasticity**

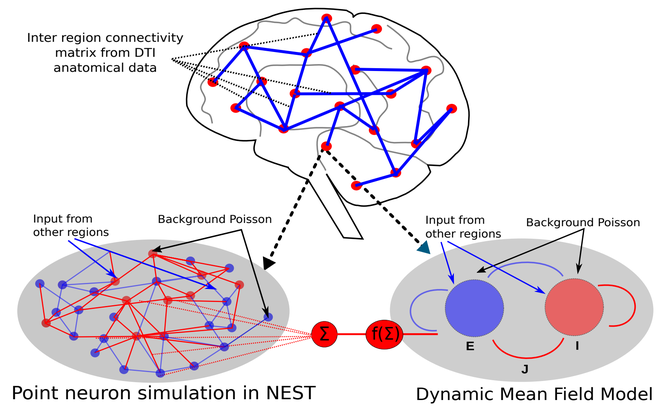
Understanding the long lasting effects of Coordinated Reset therapy



- Do structural changes influence the effectiveness of the Coordinated Reset (CR) therapy?
- Simulations of the subthalamic nucleus (STN) and the globus pallidus externus (GPe) in NEST with STDP and structural plasticity
- Synaptic and/or structural plasticity in this model takes place only in the STN group
- Simulation results match behaviour seen in experiments. Iterative CR brings better and faster desynchronization

Structural plasticity as an optimization algorithm

Fitting connectivity in large scale simulations



$$L = \alpha \sum_{i=1}^{N} (\Delta_{+i} - 1)\,\Delta_{-i} + \sum_{i=1}^{N} (\Delta_{-i} - 1)\,\Delta_{+i}\,\phi\left(\frac{1}{n(u(t))} \sum_{j=1}^{N} \omega_{ij}(u(t))\,x_j\right)$$

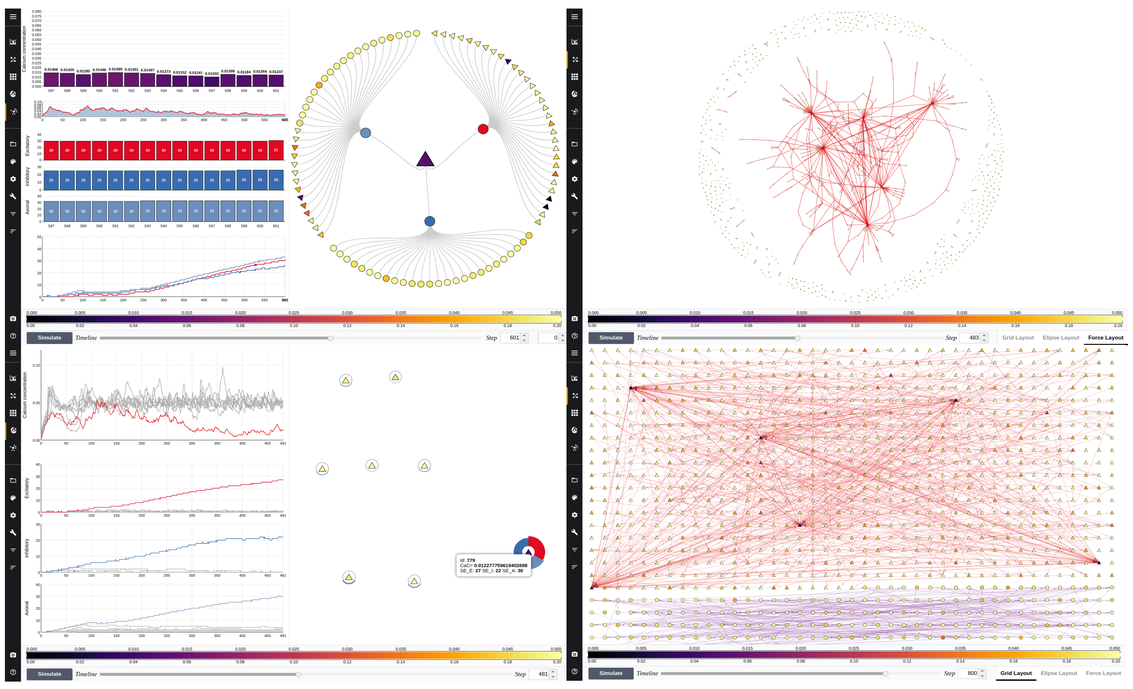
$$I_i^{(\mathrm{E})} = W_E I_0 + w_+ J_{NMDA} S_i^{(E)} + G J_{NMDA} \sum C_{ij} S_j^{(E)} - J_i S_i^{(I)} + I_{external}$$

- Connectivity fitting setup based on [Deco et. al. J. Neurosci. 2014]. Brain regions modeled as small 2 population point neuron networks in NEST and a Dynamic Mean Field (DMF) model
- Structural plasticity is used to calculate missing inner inhibition by matching experimentally measured firing rates
- Feed this information to the DMF model for long time calculations

Steering, exploring and analysing **structural plasticity**

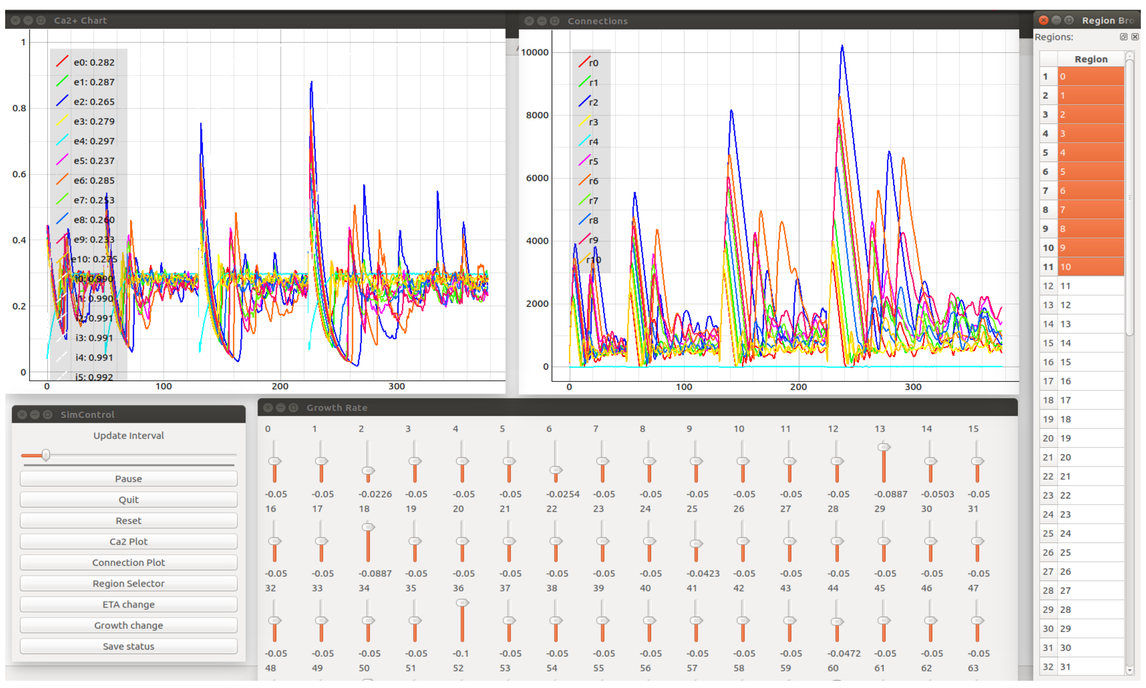
Offline analysis with MSPViz

- Offline visual analysis and exploration of the complex connectivity data generated by structural plasticity
- Different views allow structured information visualization
- Navigation through the network's dynamic structure at different scales
- Step by step detailed analysis of firing rates and connectivity



Interactive steering and visualization with nett

- Visualization and steering of structural plasticity during simulation
- Enable exploration of network trajectories and state space
- Modular design which allows steering and visualization of other variables in the network aswell
- Can be used interactively on supercomputers for large networks



Acknowledgments

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