DeNSE: modeling neuronal morphology and network structure

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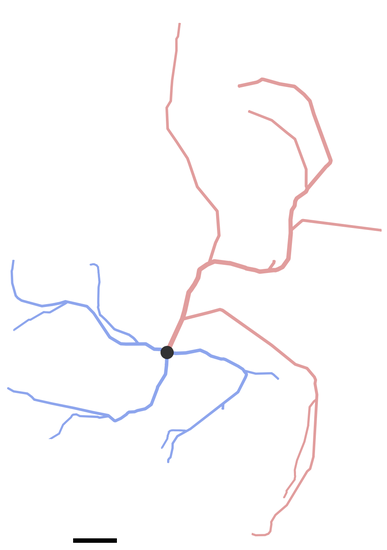
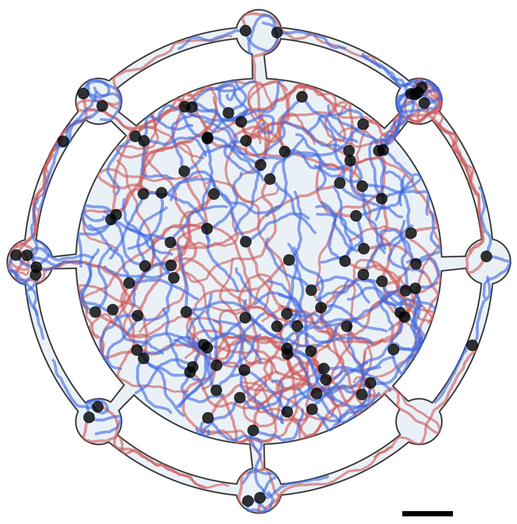
Generating complex neuronal structures



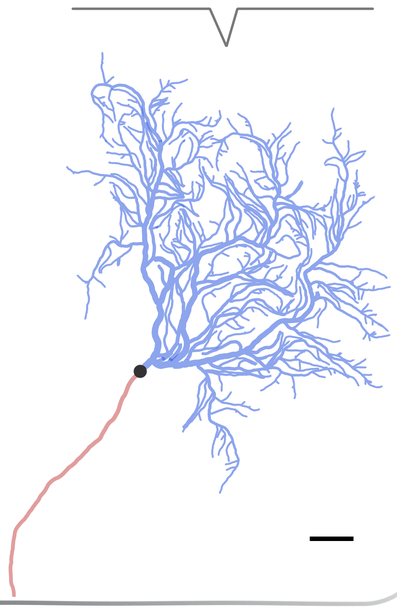
Multipolar cell with limited dendritic and axonal arborization

Axon: red
Dendrites: blue
Soma: black



Complex 2D structure containing neurons. Dendrites and axons interact both with the environment and among themselves (see fasciculation patterns)

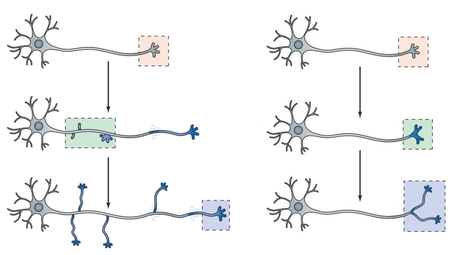
Purkinje-like cell



Growth models

Branching mechanisms:

- lateral (interstitial) branching
- growth cone split (bifurcation)



Extension mechanisms:

- random walk
- run-and-tumble
- NETMORPH + NeuroMac
- resource-driven growth

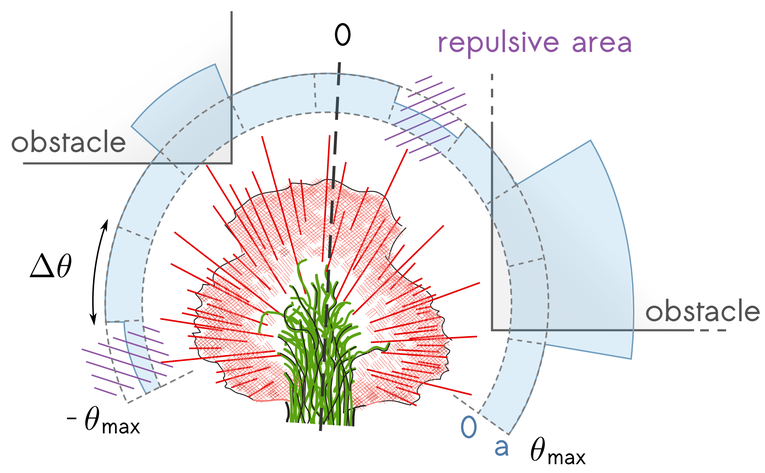
DeNSE

Freely available on GitHub!

https://github.com/SENeC-Initiative/DeNSE

Spatial interactions

Sensing:
DeNSE integrates complete sensing mechanisms. Sensitive to environment and other neurons.



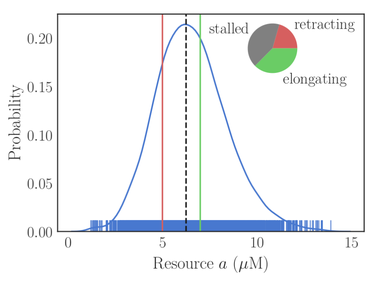
Resource and growth

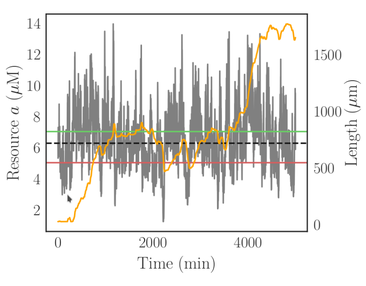
Resource:

$$\begin{cases} \dot{a}_i &= -\kappa a_i + \dfrac{A}{\tau_d}\dfrac{\zeta_i a_i}{\sum_j \zeta_j a_j} + \chi_i \\ \dot{A} &= \dfrac{A_M - A}{\tau} + \xi \end{cases}$$

Speed:

$$v = \begin{cases} \dfrac{a-\theta_r}{\theta_r} v_r < 0 & \text{if} \quad a < \theta_r \\ 0 & \text{if} \quad \theta_r \le a \le \theta_e \\ \dfrac{a-\theta_e}{a+\theta_e} v_e > 0 & \text{if} \quad \theta_e < a \end{cases}$$





Open-source software

Python frontend
Cython/C++ backend

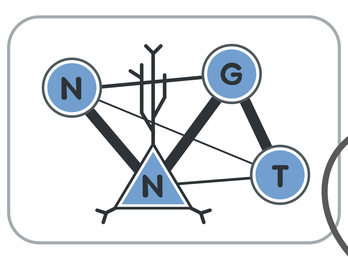
Parallel simulations (OpenMP)

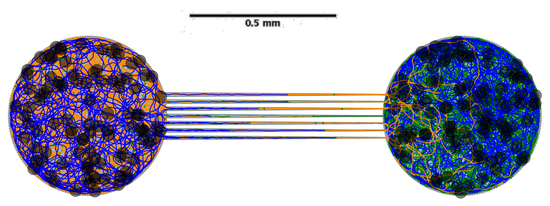
Versatile (multiple models)

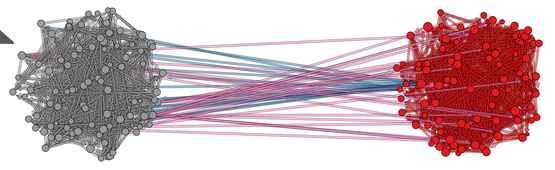
Standard compliant (SWC, NeuroML)

Scan it

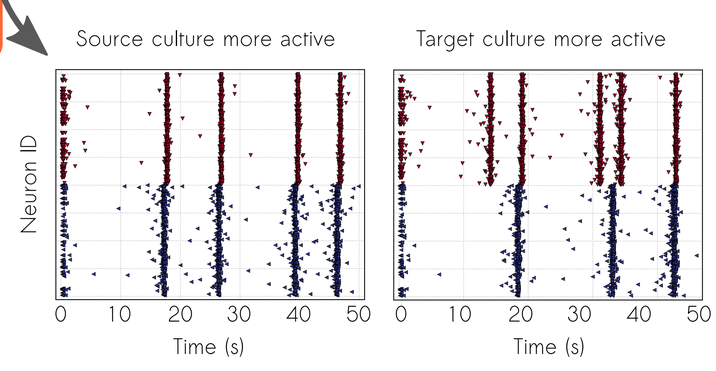
Neuronal devices







nest ::



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