Modelling Memory Across Scales

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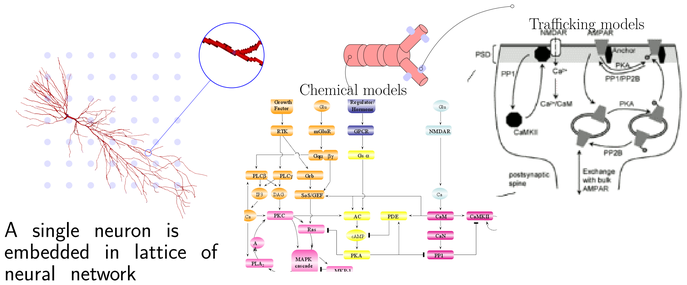
1. Why Multiscale?

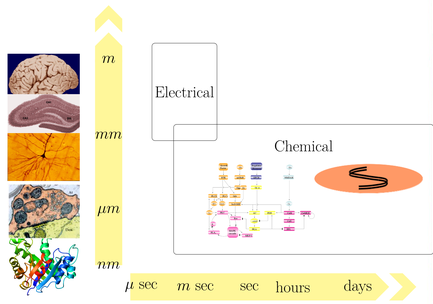
- Memory and plasticity involve brain mechanisms from molecular scale to enormous networks.
- We have developed MOOSE the Multiscale Object Oriented Simulation Environment, to model plasticity across scales.

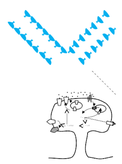


A single neuron is embedded in lattice of neural network

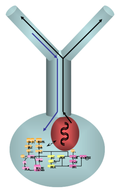
2. Multiscale Modeling in MOOSE

- 10^{11} cells, 10^{15} synapses, 10000? reactions per synapse
- Electrical events: < 1 ms, Chemical events: 1 sec $\rightarrow$ 1000 sec
- Structural events: 100 sec $\rightarrow$ months

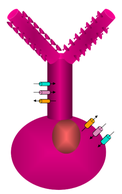




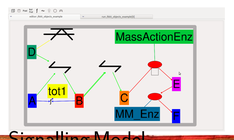
Reaction at single molecule level



Reaction Diffusion Solver

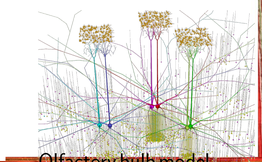


Electrical: Hines Solver



Signalling Model

Single Neuron Model

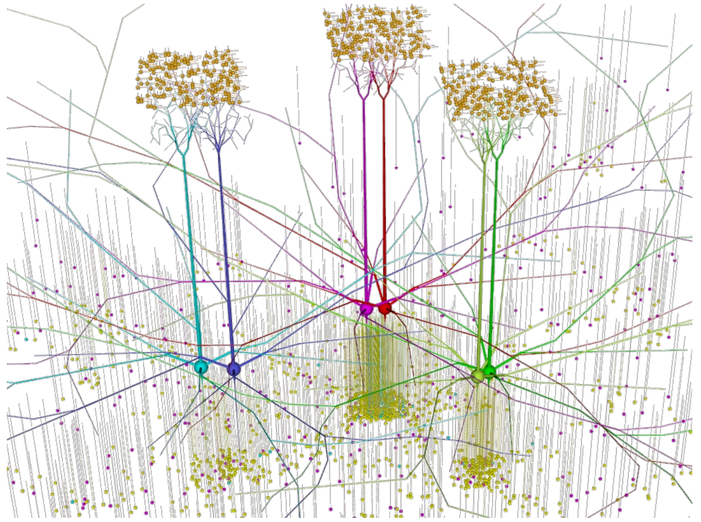


Olfactory bulb model

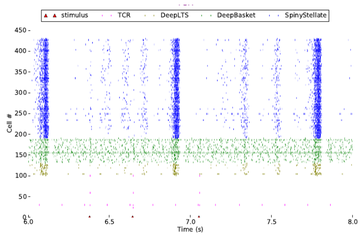
3. Some projects using MOOSE

3.1 Olfactory bulb project

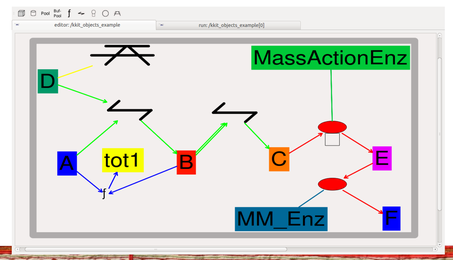
Network coding and computation in olfaction and somatosensory cortex. It explains linear coding and phase-decorrelation and predicts connectivity, lateral dendrite output structure.

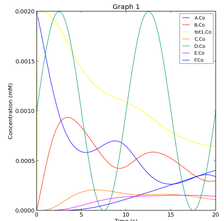


3.2 Single column Thalamacortical Model

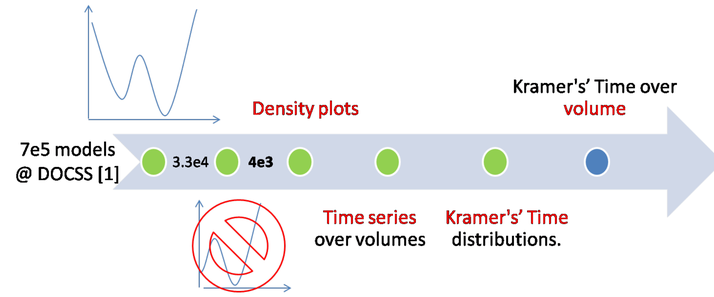


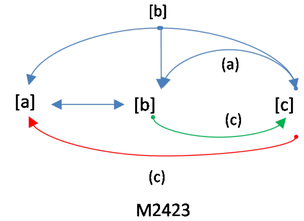
3.3 TODO: text herei

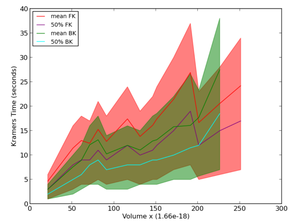


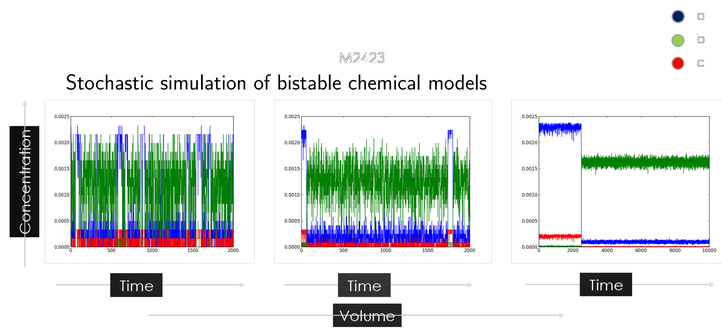


3.3 Robustness of Chemical Switches









4. Summary

We use models to,

- Integrate many scales of neuronal data with basic physical/chemical principles.
- Explain phenomena of plasticity, activity and neuronal coding.
- Predict circuit mechanisms, plasticity rules, and emergent phenomena such as *decorrelation*, *robustness*, and *memory decay*.