# Modelling Memory Across Scale

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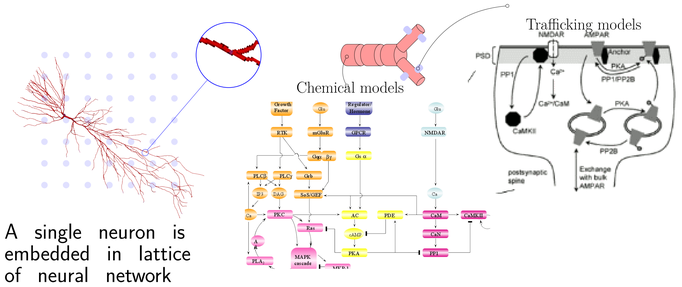
## Why Multiscale?

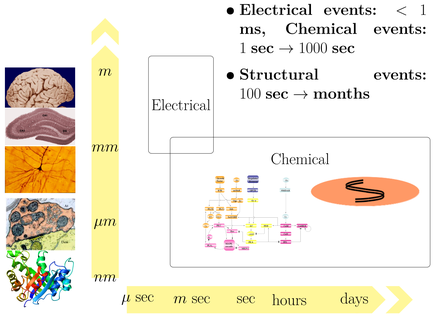
- Memory and plasticity involve brain mechanisms from molecular scale to enormous networks.
- We have developed MOOSE the Multiscale Object Oriented Simulation Environment, to model plasticity across scales.



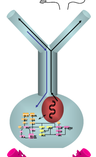

A single neuron is embedded in lattice of neural network

## Multiscale Modeling in MOOSE

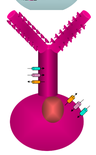
- $10^{11}$ cells, $10^{15}$ synapses, 10000? reactions per synapse
- Electrical events: $< 1$ ms, Chemical events: 1 sec $\rightarrow$ 1000 sec
- Structural events: 100 sec $\rightarrow$ months



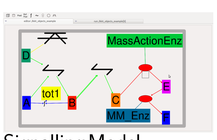

Reaction at single molecule level



Reaction Diffusion Solver



Electrical: Hines Solver

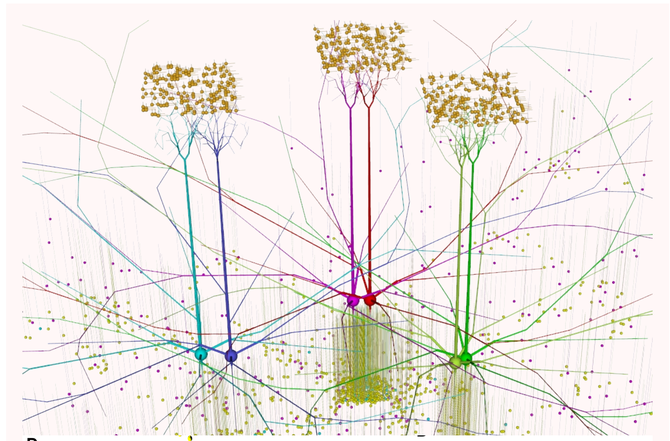


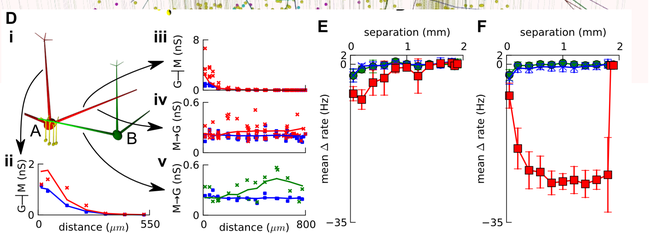

Signalling Model

Single Neuron Model

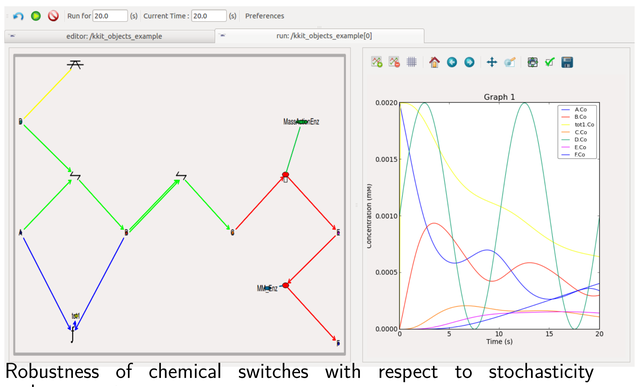
Olfactory bulb model

## Some projects using MOOSE



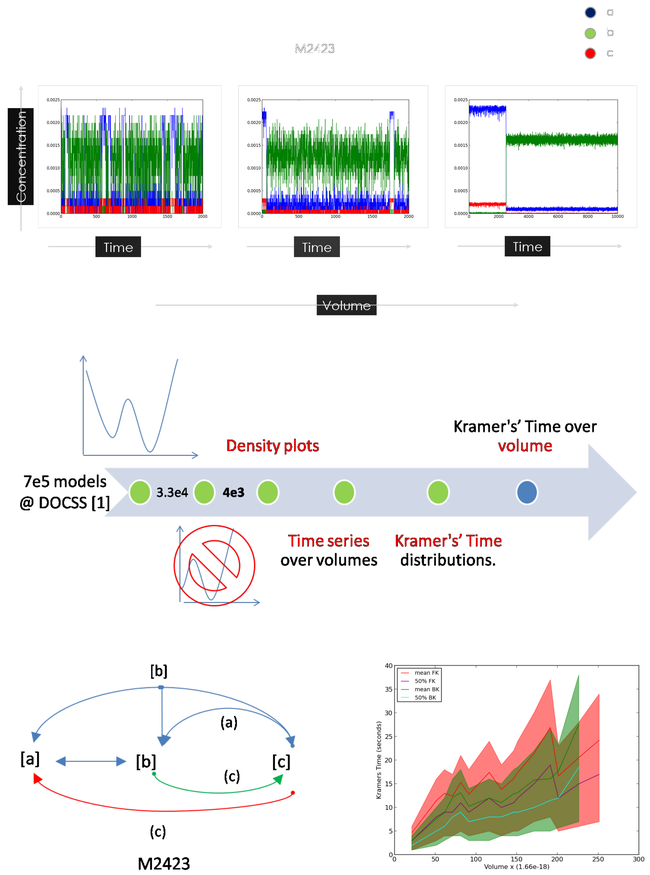



Network coding and computation in olfaction and sematosensory cortex. It explains linear coding and phase-decorrelation and predicts connectivity, lateral dendrite output structure.




Robustness of chemical switches with respect to stochasticity and parameters.

## Sahil




## Summary

We use models to

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

**We have developed MOOSE to carry out these simulations.**