The NeuroML ecosystem for standardised multi-scale modelling in neuroscience

Ankur Sinha
Silver Lab
Department of Neuroscience, Physiology, & Pharmacology
University College London
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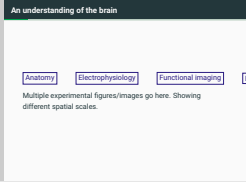
An understanding of the brain

Anatomy | Electrophysiology | Functional imaging

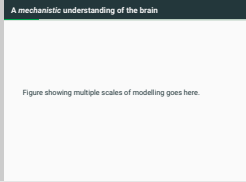
Multiple experimental figures/images go here. Showing different spatial scales.



1. Experiments provide us with direct information.
2. They study the brain at different levels.
3. There's no right level. It depends on the question being investigated.

A *mechanistic* understanding of the brain

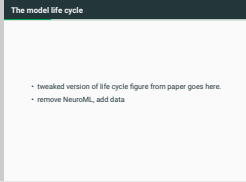
Figure showing multiple scales of modelling goes here.



1. There is so much data out there now, as we embrace Open Science.
2. Models/theory are necessary for:
3. combining independent experimental results into unified theories
4. exploring these complex systems across wider range of conditions
5. generating new testable hypotheses
6. RNNs are appropriate for lots of projects, for example.
7. So are whole brain neural mass models.
8. But, to really understand the underlying mechanisms that give rise to emergent behaviour, we must model the brain at biophysically detailed levels.

The model life cycle

- tweaked version of life cycle figure from paper goes here.
- remove NeuroML, add data



1. The figure shows a simplified model life cycle. Can be much more complex in practice.
2. Lots of tools out there for each step.
3. But there's are issues—fragmentation, lack of interoperability, so many APIs.

Standards enable FAIR neuroscience

- NWB/BIDS for data
- NeuroML/SBML etc. for modelling
- Add logos

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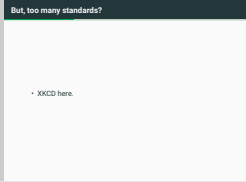
1. Standards allow the representation of data and models in specific, agreed formats.
2. They’re not neuroscience specific, of course—even programming languages have standards.
3. More importantly, if one knows what the data is going to look like, one can then develop tools and APIs around it.
4. And instead of everyone writing a tool for their own standard, every tool anyone writes for the one standard can be used with everyone’s data.

But, too many standards?

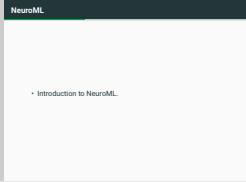
- XKCD here.



1. In neuroscience, we're fortunate enough to not have the issue of having too many standards.
2. There are only a few standards in biophysically detailed modelling, and as we'll see, we ensure that these few remain interoperable.

NeuroML

- Introduction to NeuroML.



NeuroML: scope

- Figure 2 from paper

NeuroML: scope
• Figure 2 from paper

NeuroML: software ecosystem

- Figure 3

NeuroML: software ecosystem

- Figure 3

NeuroML: software ecosystem: core tools

- Figure 4

NeuroML: software ecosystem: core tools

- Figure 4

NeuroML: create models

- Figure 5
- Code example

NeuroML: create models

- Figure 5
- Code example

NeuroML: validate models

- Figure 6

NeuroML: validate models
• Figure 6

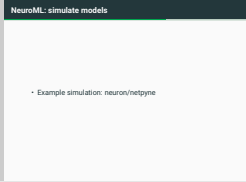
NeuroML: visualise models

- Figure 7
- Figure 8
- Figure 9

NeuroML: visualise models
• Figure 7
• Figure 8
• Figure 9

NeuroML: simulate models

- Example simulation: neuron/netpyne



NeuroML: fit models

- Figure from docs
- Mention inspyred

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NeuroML: share and re-use models

- GitHub, OSBv1, OSBv2, NeuroML-DB

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• GitHub, OSBv1, OSBv2, NeuroML-DB

NeuroML: the standard

- Schema, component types

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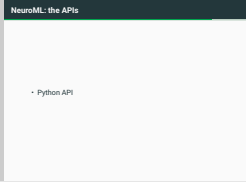
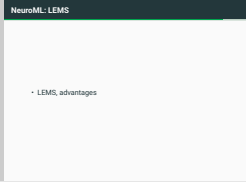
NeuroML: the APIs

- Python API



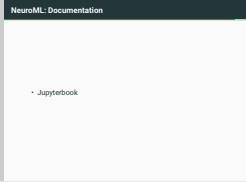
NeuroML: LEMS

- LEMS, advantages



NeuroML: Documentation

- Jupyterbook



NeuroML: projects

- GSoC, Outreachy, good computer science students

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