Neuroinformatics resources for computational modellers

Please add a brief introduction to your resource (~2 sentences) here. This will also be used in the README.md on Github

Introduction

Neuroinformatics…

Hippocampome.org: An open-access knowledge base of neuronal type properties for the rodent hippocampus

http://hippocampome.org

Hippocampome.org is a resource that combines approximately 21,000 pieces of experimental evidence about neuron types in the rodent hippocampus into a unified database. Analyzing these data has revealed about 10,500 different neuron properties and has identified over one hundred different neuron types.

Browse by morphology

Neuron Type	DG				CA1			
	SMo	SMi	SG	H	SLM	SR	SP	SO
CA1 Ivy						■	■	■
CA1 LMR					■	■		
CA1 LMR Projecting	■	■	■		■	■		
CA1 Neurogliaform					■			
CA1 Neurogliaform Projecting	■				■			

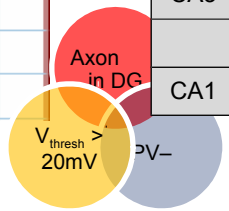
■ Axon present

■ Axon & Dendrite present

● Possible somata locations

Search by property

Neuron Types	
DG	Granule
	Mossy
CA3	Spiny Lucidum
	Mossy Fiber-Associated
CA1	**CA1 Neurogliaform Proj**



Search by author/PMID

Fuentealba P

Year	Journal	Neuron Types
2005	J Neurosci	Schaffer Collateral-Associated
2007	J Neurosci	CA1 Trilaminar
2008	Neuron	CA1 Neurogliaform **CA1 Neurogliaform Proj**
2008	J Neurosci	CA1 Hippocampo-Subicular Proj ENK+
2010	J Neurosci	CA1 Pyramidal CA1 Neurogliaform **CA1 Neurogliaform Proj**

Neuron type page

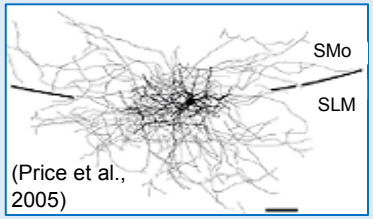
CA1 Neurogliaform Proj

Synonyms

List of articles

Morphology
- Soma: CA1 SLM
- Axons: DG SMo, CA1 SLM
- Dendrites: DG SMo, CA1 SLM

Representative figure



(Price et al., 2005)

Molecular markers
- Positive: CoupTFII, RLN, …
- Negative: CB, DYN, PV, VIP, …
- Mixed expression: CCK, CR, …

Electrophysiological Parameters
- V_{rest}, R_{in}, τ_m, V_{thresh}, AP_{width}, …

Connectivity
- Sources of input
- Targets of output

Evidence pages

CA1 Neurogliaform Proj
V_{thresh} Evidence Page

Interpretation: pa
Protocol: pa

Source: Pric
Kulik A, Lam
Capogna M.
novel inhibito
hippocampal
25 (29), page
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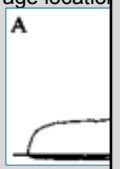

Linking PM
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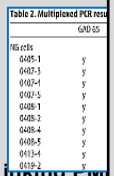
CA1 Neurogliaform Proj
PV Evidence Page

Interpretation:
Protocol: mF

Source: Pric
Kulik A, Lam
Capogna M.
novel inhibito
CA1 area. *J*
pages: 6775-

Page locatio



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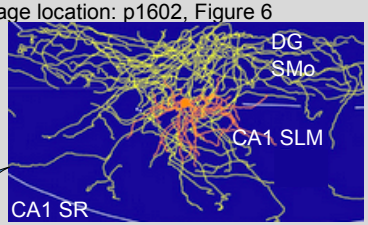
CA1 Neurogliaform Proj
Axon Evidence Page

Interpretation: Axons in DG SMo

Source: Fuentealba P, Klausberger T, Karayannis T, Suen WY, Huck J, Tomioka R, Rockland K, Capogna M, Studer M, Morales M, Somogyi P. Expression of COUP-TFII nuclear receptor in restricted GABAergic neuronal populations in the adult rat hippocampus. *J Neurosci*, 2010, 30 (5), pages: 1595-1609. PMID: 20130170

Page location: p1602, Figure 6



"Axodendritic distribution and molecular profile of neurogliaform cells recorded in vivo. ... B, Partial reconstruction of the neurogliaform cell (T126c). Top: soma and dendrites complete (orange), axonal arborization (yellow) only from 5 coronal sections (60 µm). Note the dendrites biased to [SLM]."

Browse by biomarker

Neuron Type	CB	CR	PV	CCK	VIP	CoupTF II	RLN	DYN
CA1 Ivy	◀▶	◀	◀	◀	◀			
CA1 LMR		◀	◀	▶	▶	▶	◀	
CA1 LMR Projecting	▶	◀	◀	▶	◀			
CA1 Neurogliaform	◀	◀▶	◀	◀▶	◀	▶	▶	◀
CA1 Neurogliaform Projecting	◀	◀▶	◀	◀▶	◀	▶	▶	◀

▶ Positive

◀ Negative

◀▶ Positive-Negative (subtypes)

No data found

Search incomplete

Browse by electrophysiology

Neuron Type	V_{rest} (mV)	R_{in} (MΩ)	τ_m (ms)	V_{thresh} (mV)
CA1 Ivy	-71.0	72.8	7.6	30.1
CA1 LMR	-53.1	352.0	32.9	36.9
CA1 LMR Projecting				
CA1 Neurogliaform	-63.1	215.3	12.4	32.4
CA1 Neurogliaform Projecting	-63.1	215.3	12.4	44.4

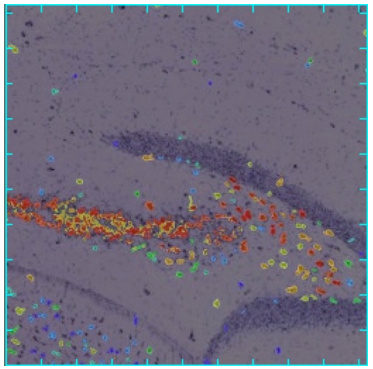
Neuron Term Portal

Initial	Neuron Term - Selector
S	soma

Resource	Definition
Neurolex	The portion of a neuron that includes the nucleus, but excludes cell projections such as axons & dendrites.
CRISP	The cell body of a neuron.
Gene Ontology	The portion of a cell bearing surface projections such as axons, dendrites, cilia, or flagella that includes the nucleus, but excludes all cell projections.

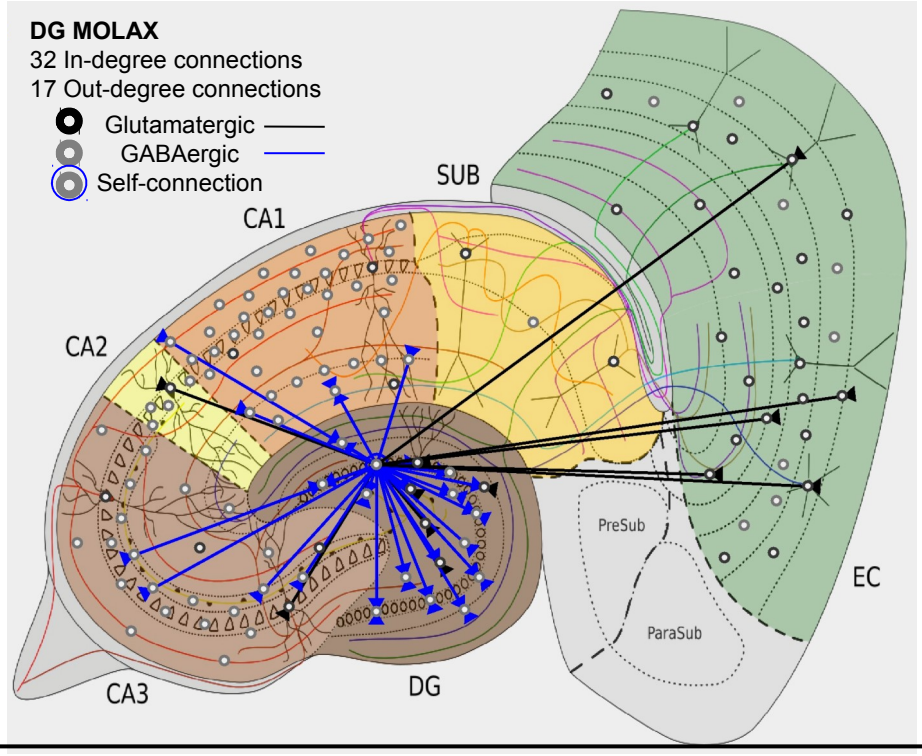
Allen Mouse Brain Atlas data

- Focus on principal cell layers of DG, CA3, CA2, CA1.
- Mouse in situ hybridization data.
- Increases the biomarker pieces of knowledge (PoK) from ~1100 to more than ~6800.



Acetylcholinesterase (Ache) is expressed in CA3c Pyramidal cells and not expressed in DG Granule cells.

Interactive connectivity navigator



Forthcoming additions

Biomolecular marker inferences

- Relational expression inferences supplement direct expression evidence.
- Contrapositive inferences.

Firing pattern phenotypes

- 9 firing pattern elements.

Modeling firing patterns

- Firing patterns simulated using Izhikevich models (IEEE Trans Neural Netw 14:1569-1572 (2003)).

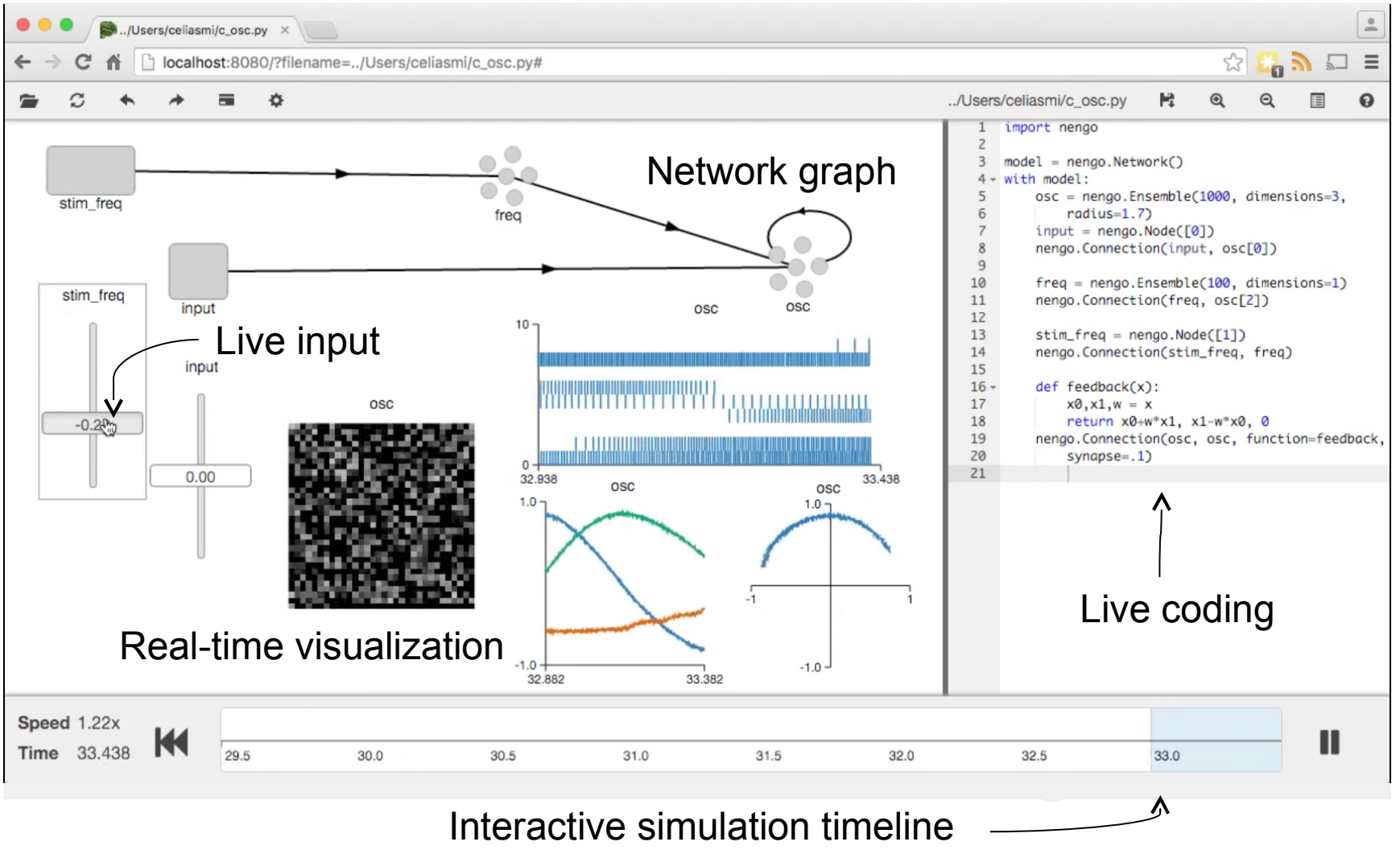
New neuron types

- Splitting of CA1 Pyramidal cells into Superficial and Deep types.
- Inclusion of Adult-Born Immature Granule cells.

Nengo 2.0

http://nengo.github.io/

Nengo is a graphical and scripting based software package for simulating large-scale spiking and non-spiking neural systems. It supports CPUs, GPUs (single and multi), MPI, and neuromorphic chips.




```
1  import nengo
2
3  model = nengo.Network()
4  with model:
5      osc = nengo.Ensemble(1000, dimensions=3,
6          radius=1.7)
7      input = nengo.Node([0])
8      nengo.Connection(input, osc[0])
9
10     freq = nengo.Ensemble(100, dimensions=1)
11     nengo.Connection(freq, osc[2])
12
13     stim_freq = nengo.Node([1])
14     nengo.Connection(stim_freq, freq)
15
16     def feedback(x):
17         x0,x1,w = x
18         return x0+w*x1, x1-w*x0, 0
19     nengo.Connection(osc, osc, function=feedback,
20         synapse=.1)
21
```

Documentation -- Usage and API documentation is at:

https://pythonhosted.org/nengo/

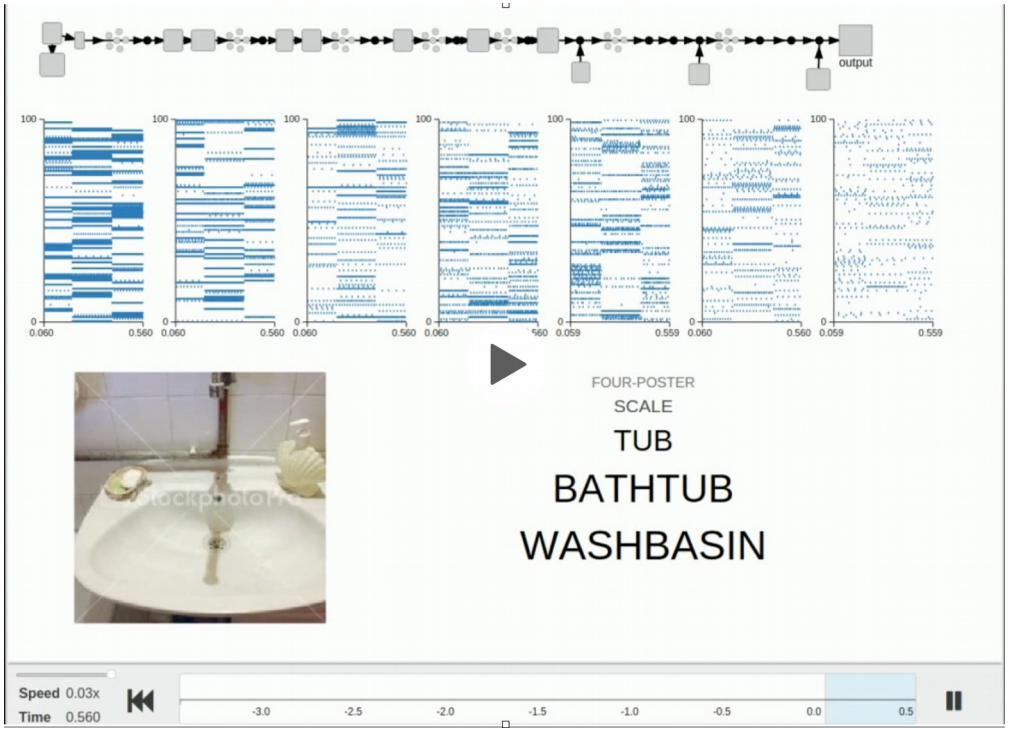
Getting Help -- Nengo forum at:

https://forum.nengo.ai

Screen cap from https://youtu.be/UVeIPKnQAL4

Application Highlights

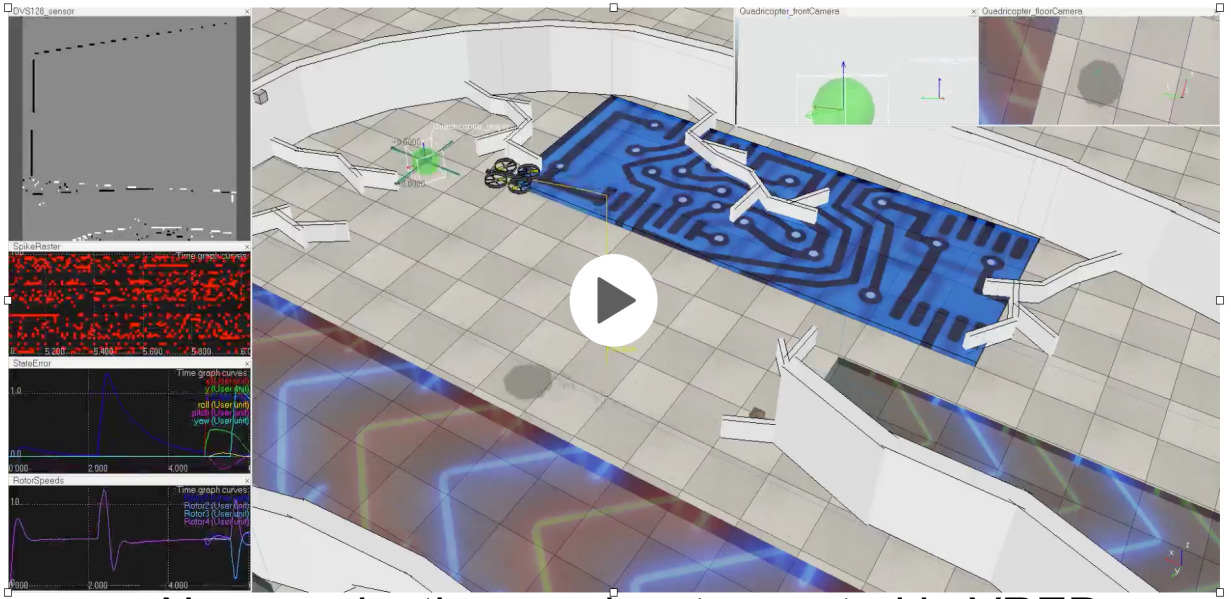
- Used to develop large-scale spiking deep networks
- Integration with robot simulators & platforms
- 6 DOF nonlinear adaptive control on neuromorphic hardware for 30x power savings
- Spaun large-scale neuro-cognitive model published in *Science*



Spiking ImageNet in Nengo
https://youtu.be/7R5F4mNURGc

Strengths

- *Scalability*: simulate millions of neurons efficiently
- *Integration*: combine deep learning, spiking, recurrent, and NEF networks
- *Learning*: on-line, spike-based, off-line, batch processing, STDP, RL, customizable



Nengo adaptive quadcopter control in VREP
https://youtu.be/KBwBX7bzohA

More Nengo Resources

In Development

- More complete NEURON integration
- Fully featured Semantic Pointer Architecture (SPA) library for cognitive modeling
- Additional tools for TensorFlow integration (Nengo DL)
- Additional backends for FPGAs, neuromorphic ASICs, etc.

Online Tutorials & Examples (in addition to documentation)

- Covering NEF and SPA methods in Nengo GUI

https://github.com/nengo/nengo_gui/tree/master/nengo_gui/examples/tutorial

- >40 Jupyter notebook examples covering core Nengo usage

https://pythonhosted.org/nengo/examples.html

- To accompany the book How to Build a Brain (2013)

https://github.com/nengo/nengo_gui/tree/master/nengo_gui/examples/hbb_tutorials

Additional resources

- Annual Nengo Summer School

http://nengo.ca/summerschool

- Information for current or prospective developers can be found at

https://nengo.github.io/contributing.html

Open Source Brain

http://www.opensourcebrain.org

Open Source Brain is...

One slide giving an overview of the resource, example datasets, etc.

One slide discussing current work/future plans

Optional 3rd slide…

General requests:

- Please favour graphical content over text where possible

- Please don't use animation (use multiple slides if required)

- Try to keep to font Arial

- Save slides as .pptx (Powerpoint 2007-2013); slides will be concatenated into a single PDF presentation

NeuroML

http://www.neuroml.org

NeuroML is a language for expressing models in computational neuroscience in a simulator independent, standardised format. It can express models from integrate and fire cells to complex networks of multicompartmental neurons.

Standardised XML language for computational neuroscience

Version 1.x allowed specification of:

- Detailed neuronal morphologies
- Ion channels
- Synapses
- 3D network structure

30+ simulators/applications/ databases/libraries support NeuroML

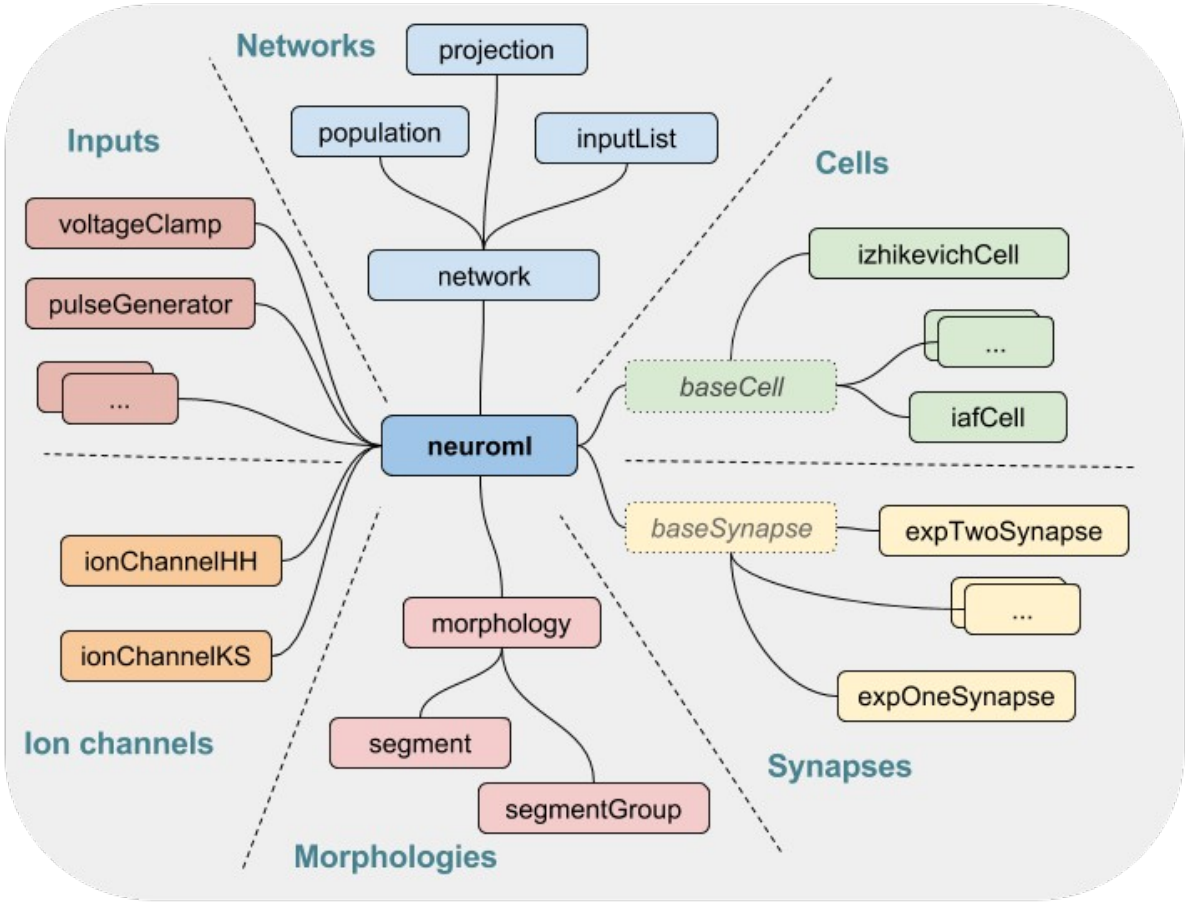
Simulators
NEURON
GENESIS
MOOSE
Brian

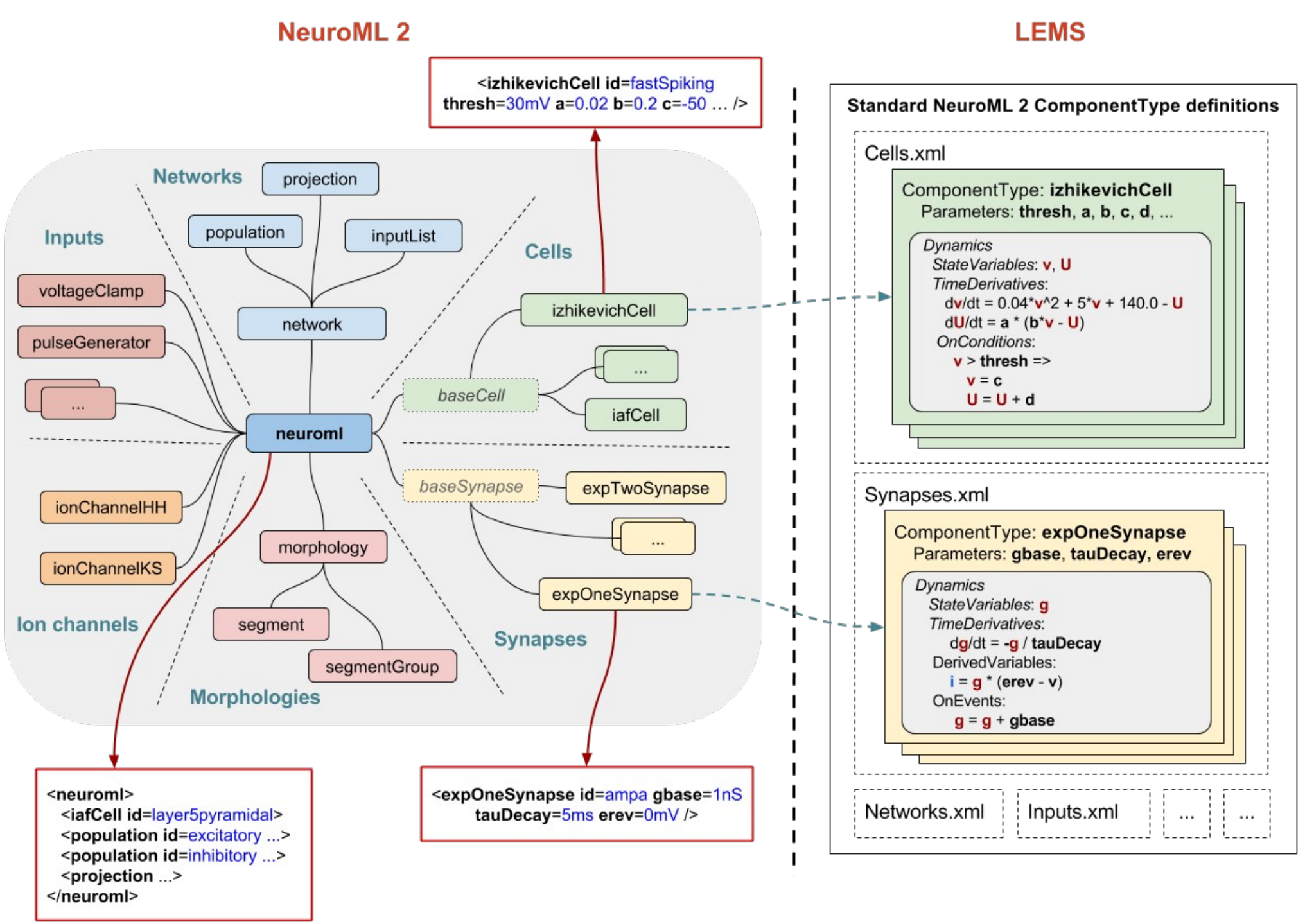
Interoperability
PyNN
neuroConstruct

Initiatives
OpenWorm
Open Source Brain

Databases
Channelpedia
BBP NMC
NeuroMorpho
Allen Institute Cell Types DB

Morphological analysis/ generation
Cx3D
TREES Toolbox
NeuGen


Networks
projection
population
inputList
network
Inputs
voltageClamp
pulseGenerator
...
ionChannelHH
ionChannelKS
Ion channels
neuroml
Cells
izhikevichCell
baseCell
...
iafCell
baseSynapse
expTwoSynapse
...
expOneSynapse
Synapses
morphology
segment
segmentGroup
Morphologies


NeuroML 2
LEMS
<izhikevichCell id=fastSpiking thresh=30mV a=0.02 b=0.2 c=-50 … />
Networks
projection
population
inputList
Inputs
Cells
voltageClamp
network
izhikevichCell
pulseGenerator
...
baseCell
...
iafCell
...
neuroml
baseSynapse
expTwoSynapse
ionChannelHH
...
morphology
ionChannelKS
expOneSynapse
Ion channels
segment
Synapses
segmentGroup
Morphologies
<neuroml>
<iafCell id=layer5pyramidal>
<population id=excitatory ...>
<population id=inhibitory ...>
<projection ...>
</neuroml>
<expOneSynapse id=ampa gbase=1nS tauDecay=5ms erev=0mV />
Standard NeuroML 2 ComponentType definitions
Cells.xml
ComponentType: izhikevichCell
Parameters: thresh, a, b, c, d, ...
Dynamics
StateVariables: v, U
TimeDerivatives:
dv/dt = 0.04*v^2 + 5*v + 140.0 - U
dU/dt = a * (b*v - U)
OnConditions:
v > thresh =>
v = c
U = U + d
Synapses.xml
ComponentType: expOneSynapse
Parameters: gbase, tauDecay, erev
Dynamics
StateVariables: g
TimeDerivatives:
dg/dt = -g / tauDecay
DerivedVariables:
i = g * (erev - v)
OnEvents:
g = g + gbase
Networks.xml
Inputs.xml
...
...