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N2A: a language and software tool for large-scale modeling

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Summary

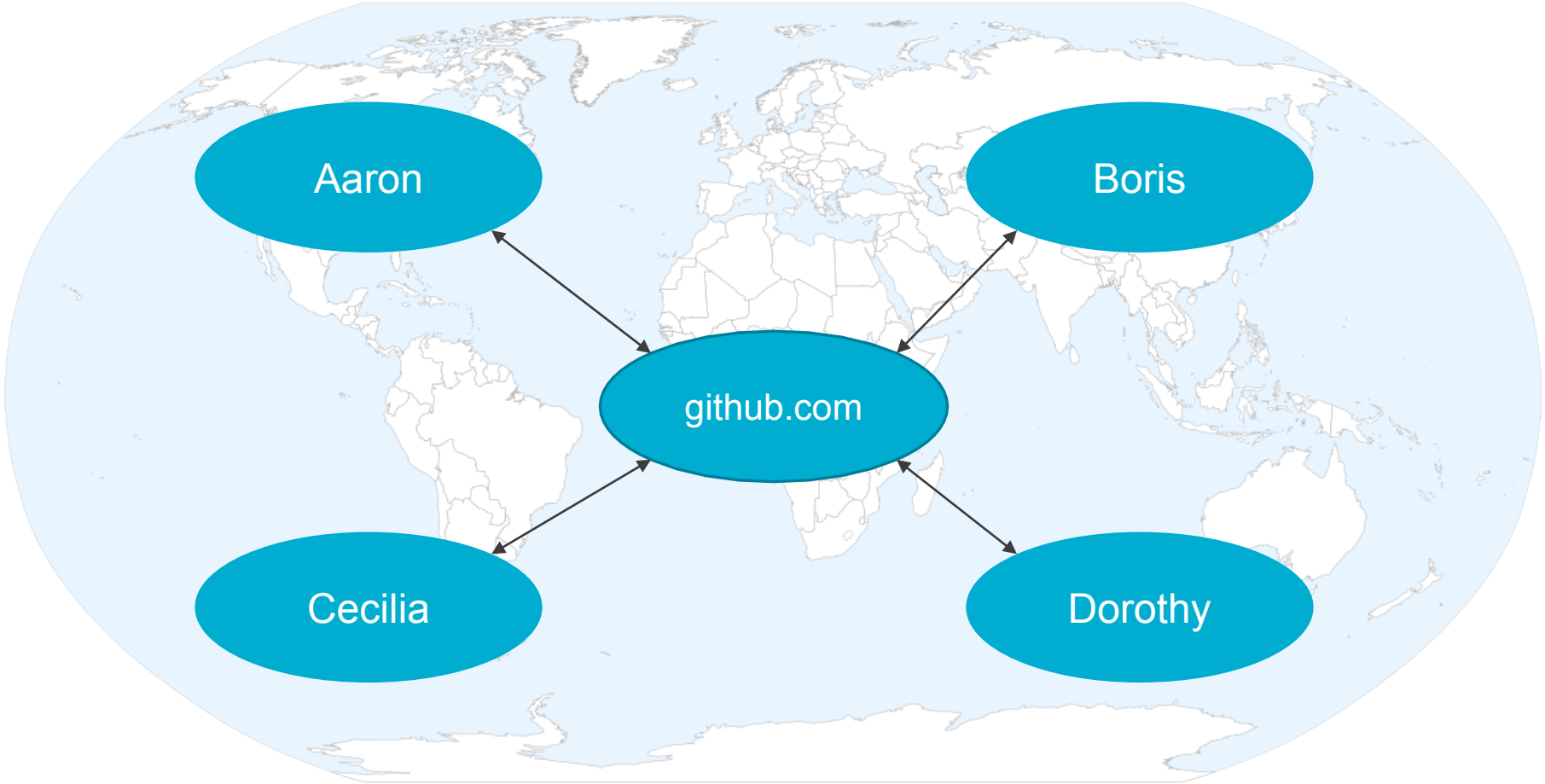
- Dynamical system modeling language and tool
- Simulator agnostic
- Enables teams of neuroscientists to collaborate on large-scale / complex models

- Parts defined with simple set of equations. No need to program.
- Build complex structures from simple structures by reusing parts.

- Publicly available: https://github.com/frothga/n2a
- Continuous development, supported by major national laboratory

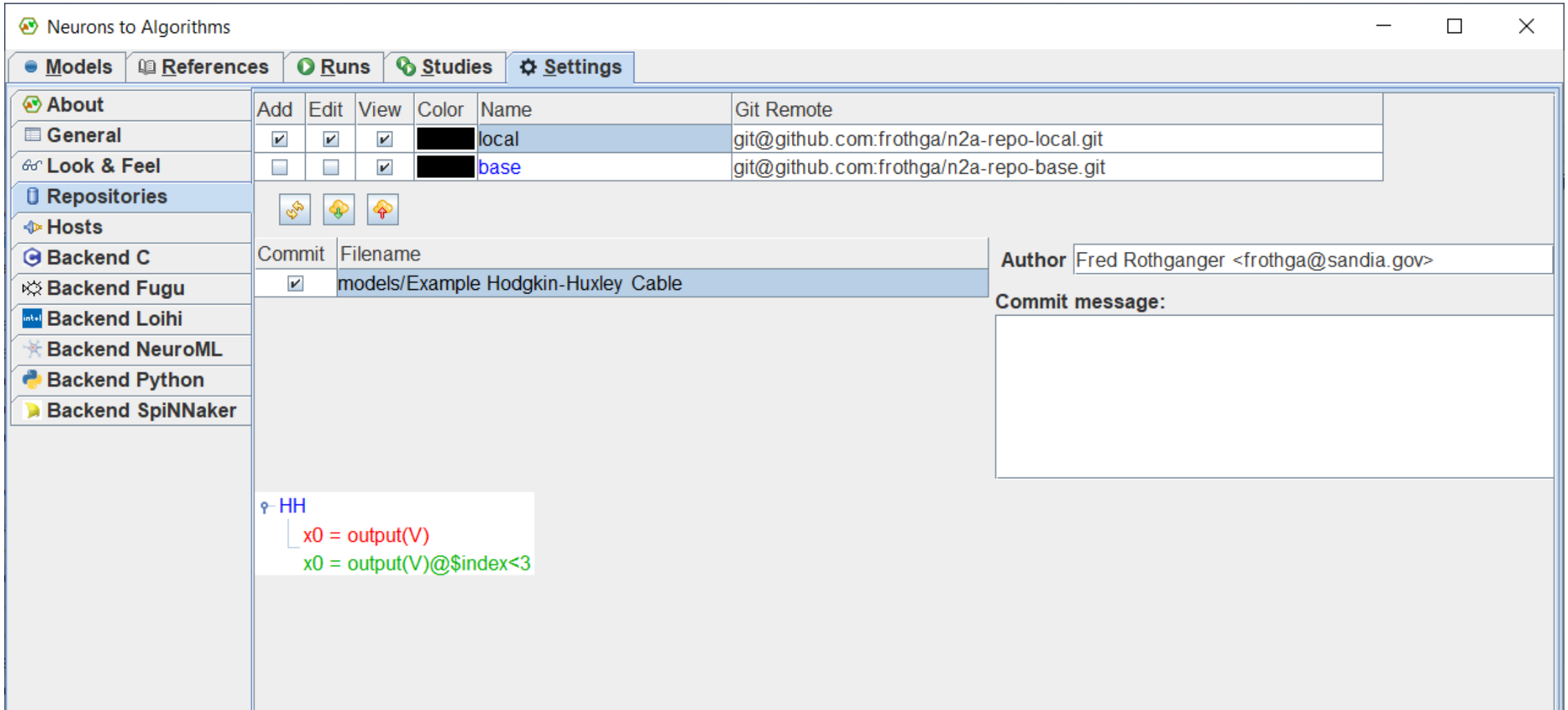
Collaboration

- Repository – collection of Parts, version-controlled with git
- Each user can have several repositories
- Each repo can be linked with an upstream git server

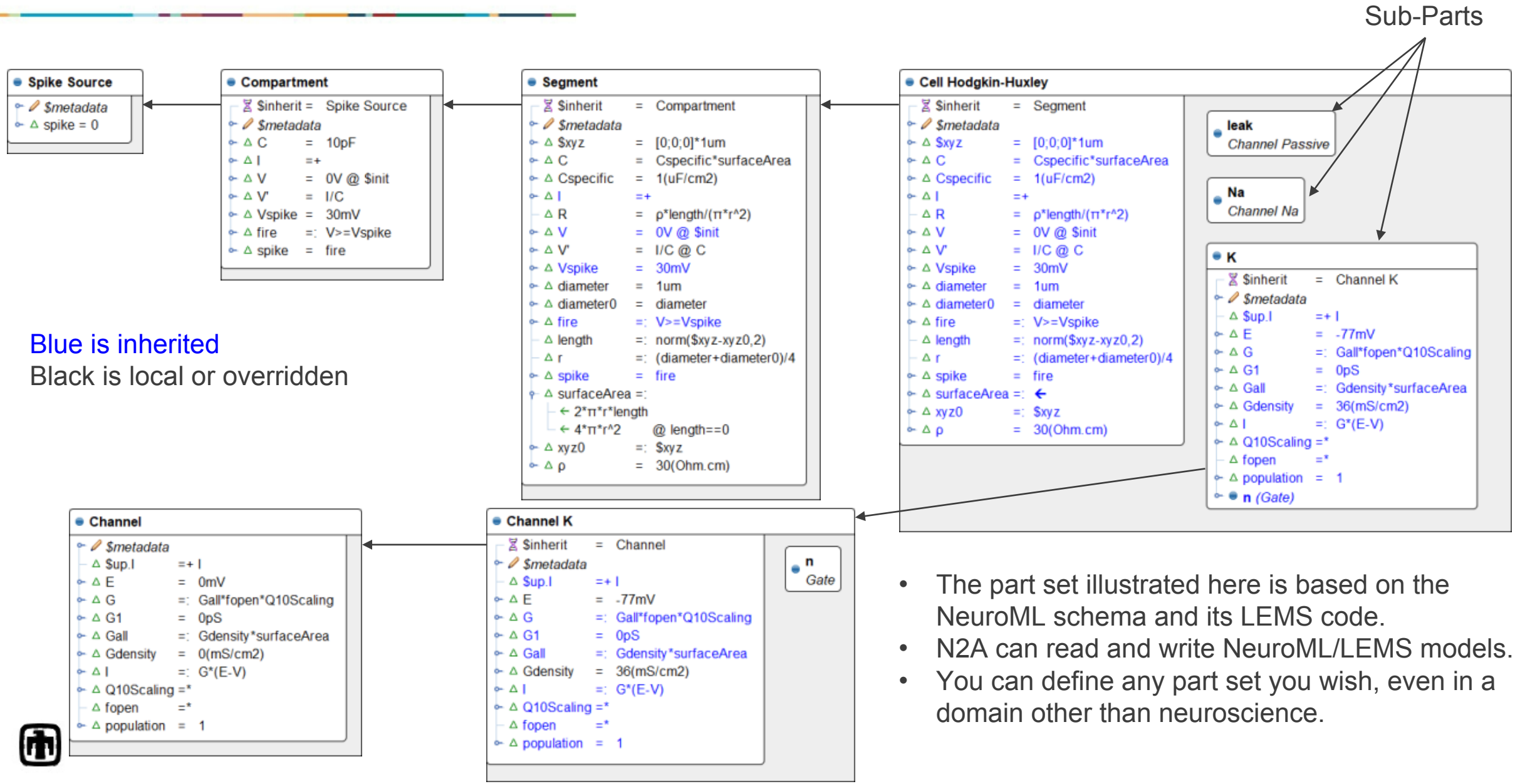


Collaboration

- UI for managing repositories
- Merges Git pulls correctly, preserving local work



Inheritance



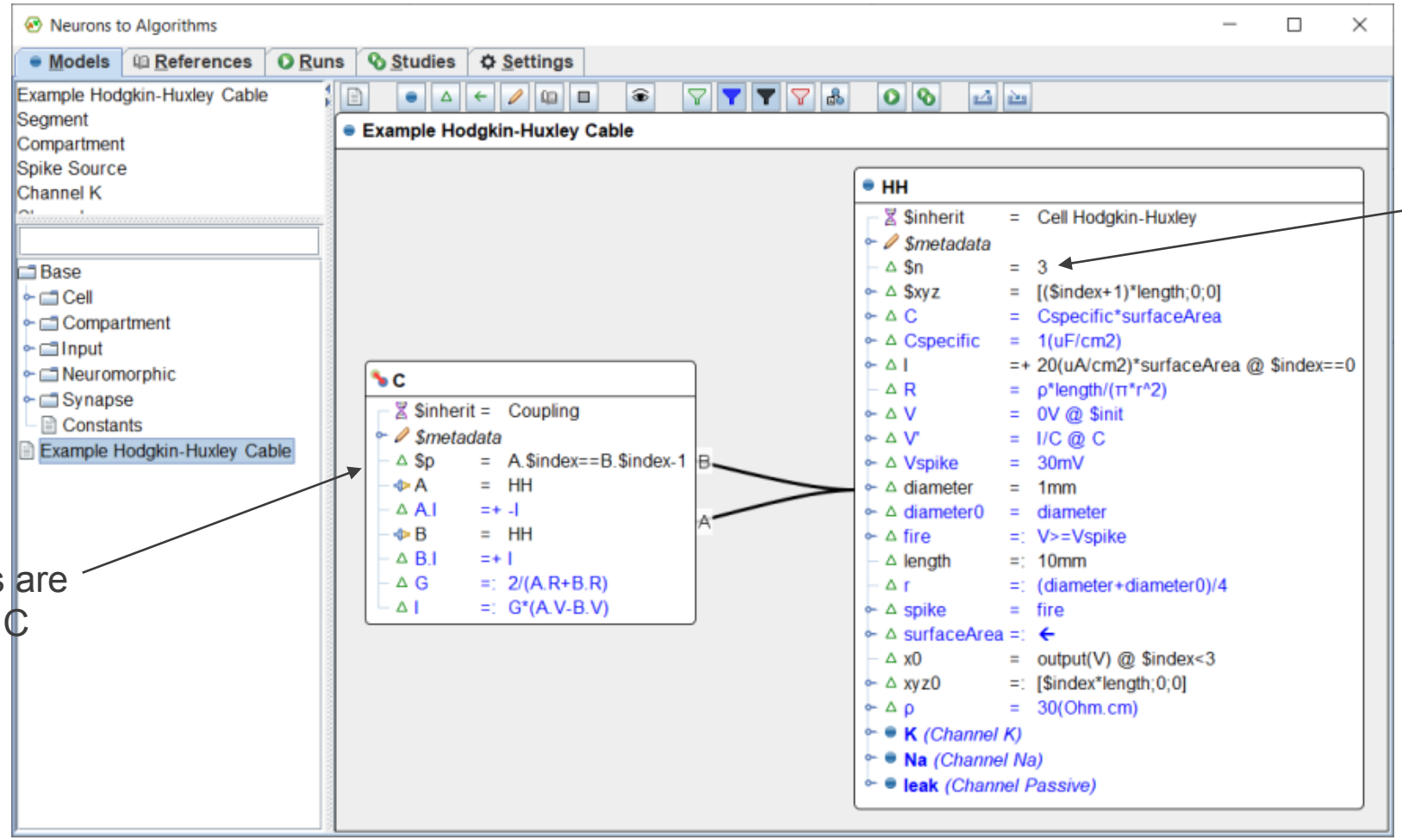
Blue is inherited

Black is local or overridden

- The part set illustrated here is based on the NeuroML schema and its LEMS code.
- N2A can read and write NeuroML/LEMS models.
- You can define any part set you wish, even in a domain other than neuroscience.

Connections

- Join Part instances together at runtime

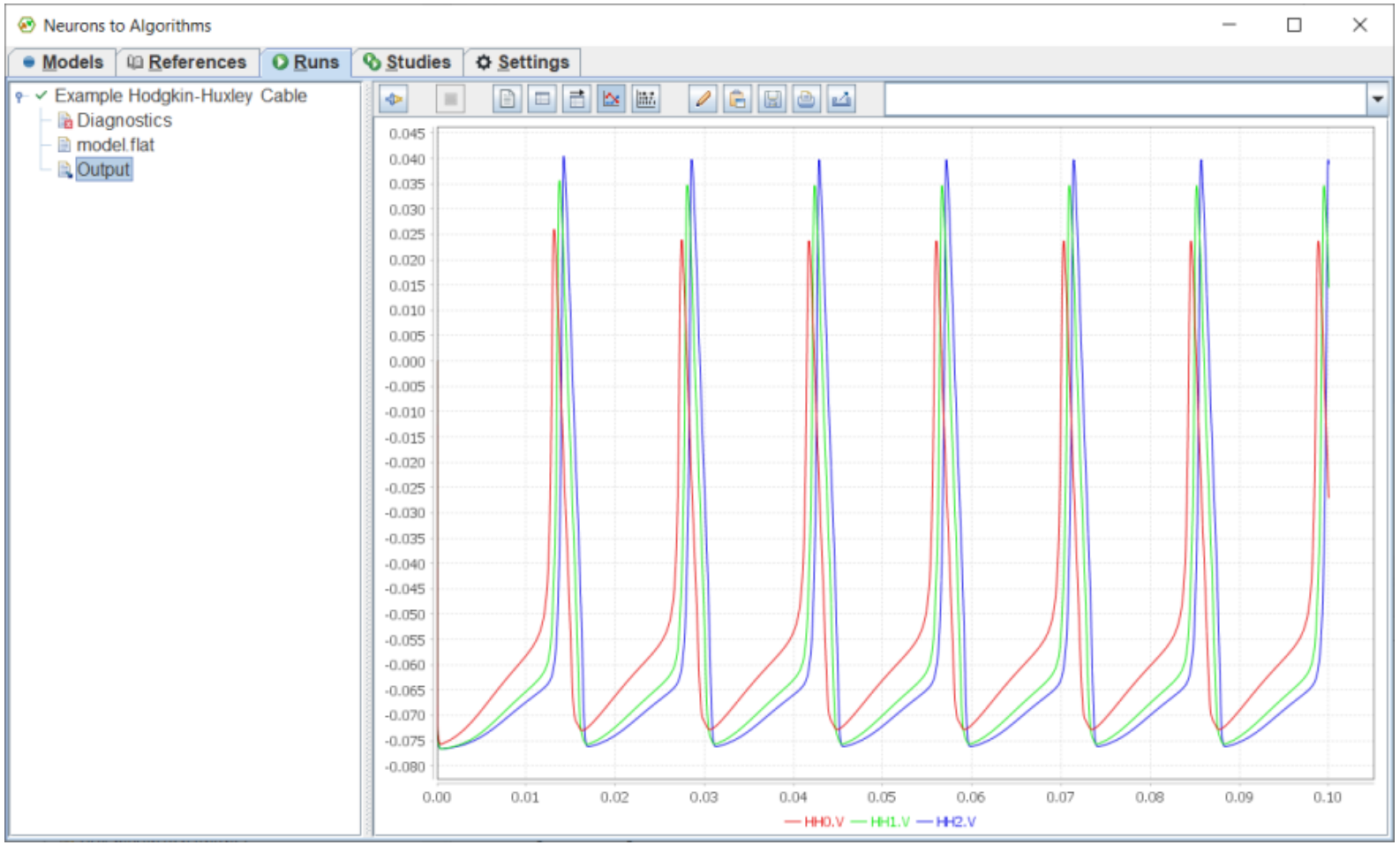


3 instances of HH are created

Adjacent HH instances are electrically coupled by C

Simulation

- Full-featured implementations in Java (internal) and C.
- Limited implementations for LEMS, Xyce (HPC Spice), Loihi and SpiNNaker.
- Currently developing HPC/GPU backend, targeting either NEST or STACS.

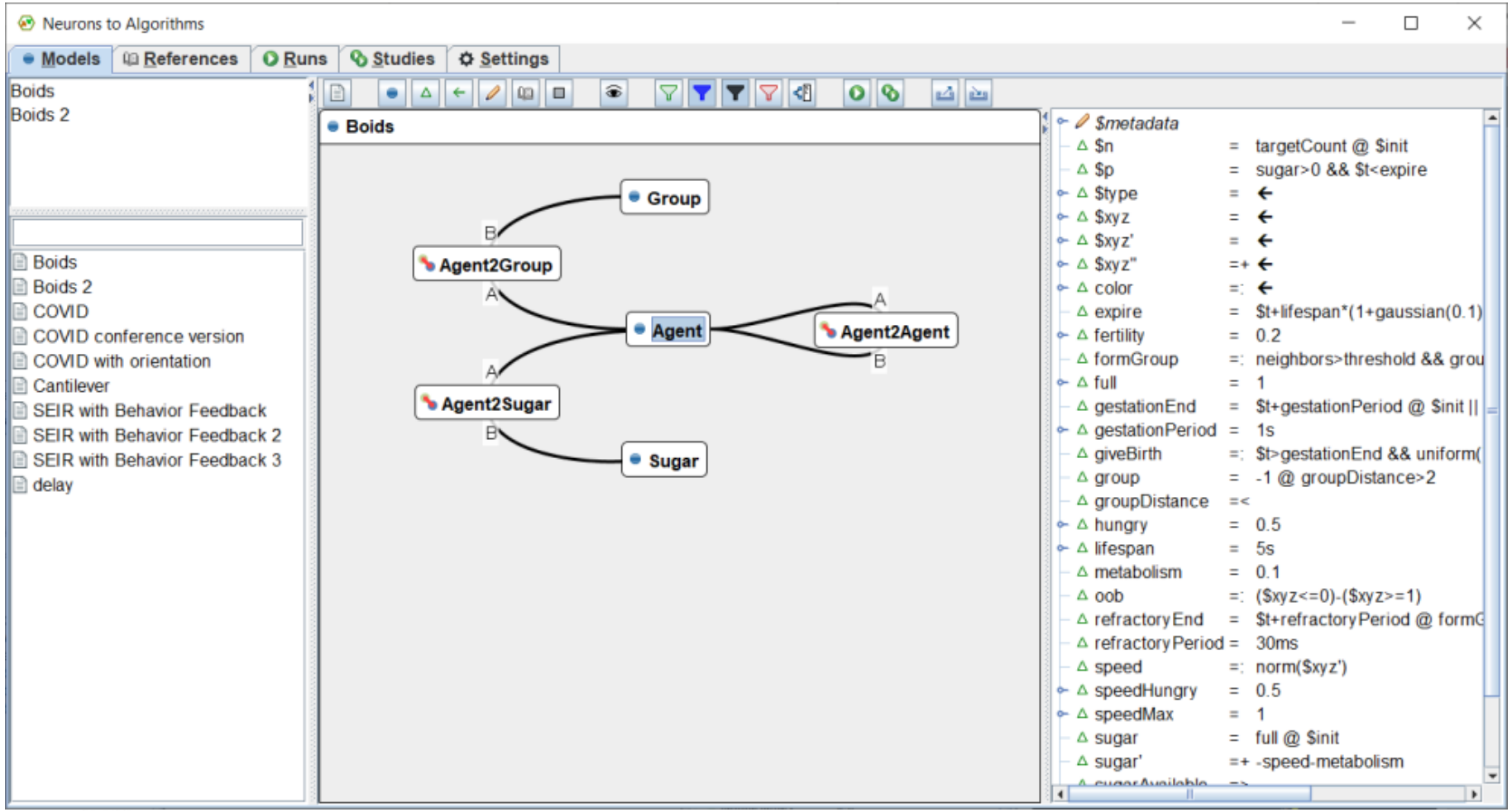


This graph shows the 3 HH compartments as a spike travels down the line. There are roughly 7 cycles of spike transmission.

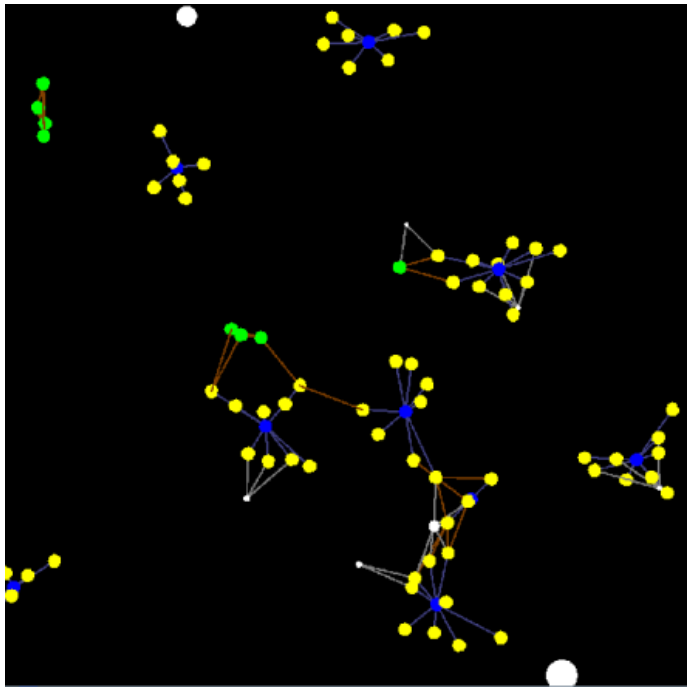
Note that the first compartment (HH0) is receiving current injection.

Higher-level models

- Goal is large-scale / complex brain models
- Tool is also used for social-science, such as group formation and COVID behavior.



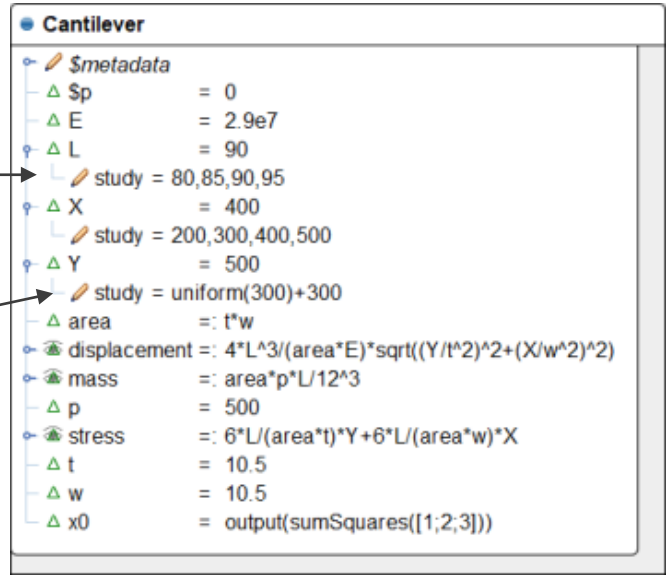
One frame from video output:



Parameter sweeps and Optimization

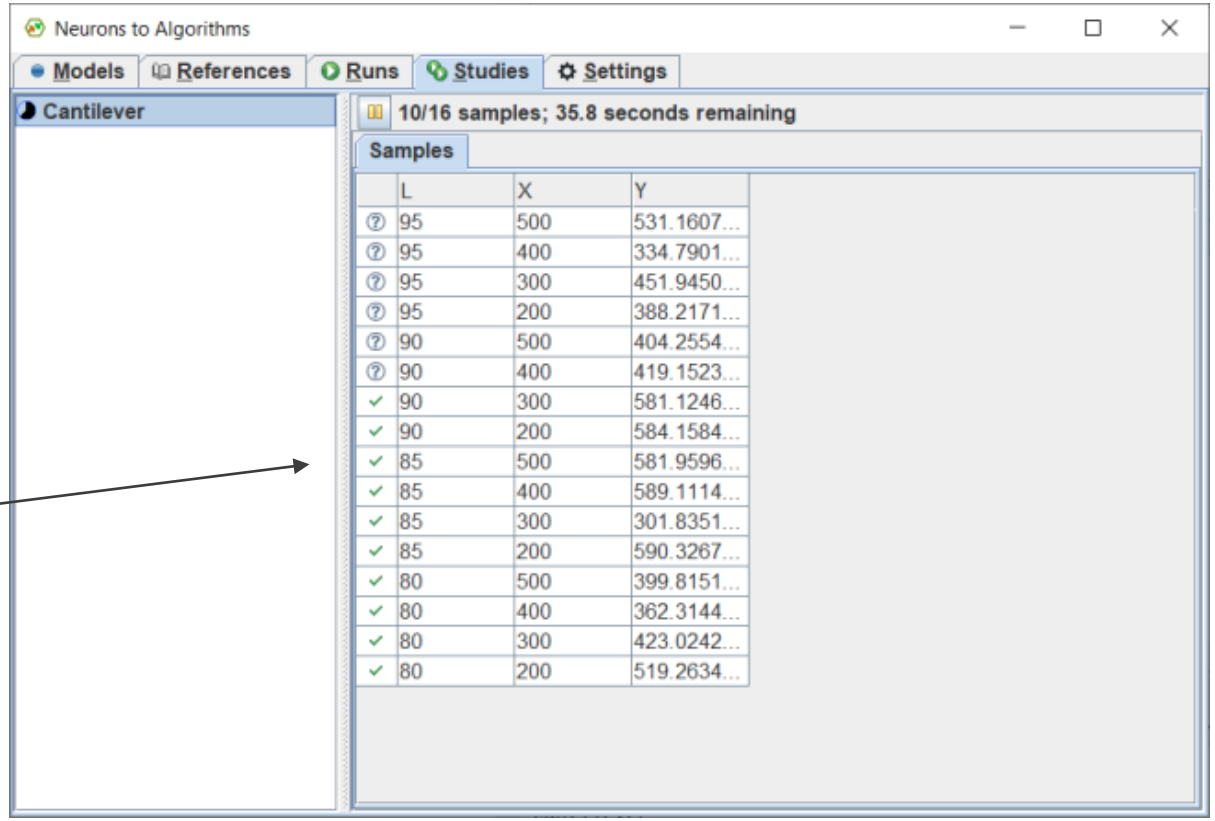
Tags tells Study tool to generate parameter variations.

This tag generates a random number.



Study tool generates the permutations.
Study can task multiple cores and multiple host systems.

Optimization is still in development. In this case, the Study tool will select new parameters based on simulation results and a loss function.



	L	X	Y
?	95	500	531.1607...
?	95	400	334.7901...
?	95	300	451.9450...
?	95	200	388.2171...
?	90	500	404.2554...
?	90	400	419.1523...
✓	90	300	581.1246...
✓	90	200	584.1584...
✓	85	500	581.9596...
✓	85	400	589.1114...
✓	85	300	301.8351...
✓	85	200	590.3267...
✓	80	500	399.8151...
✓	80	400	362.3144...
✓	80	300	423.0242...
✓	80	200	519.2634...