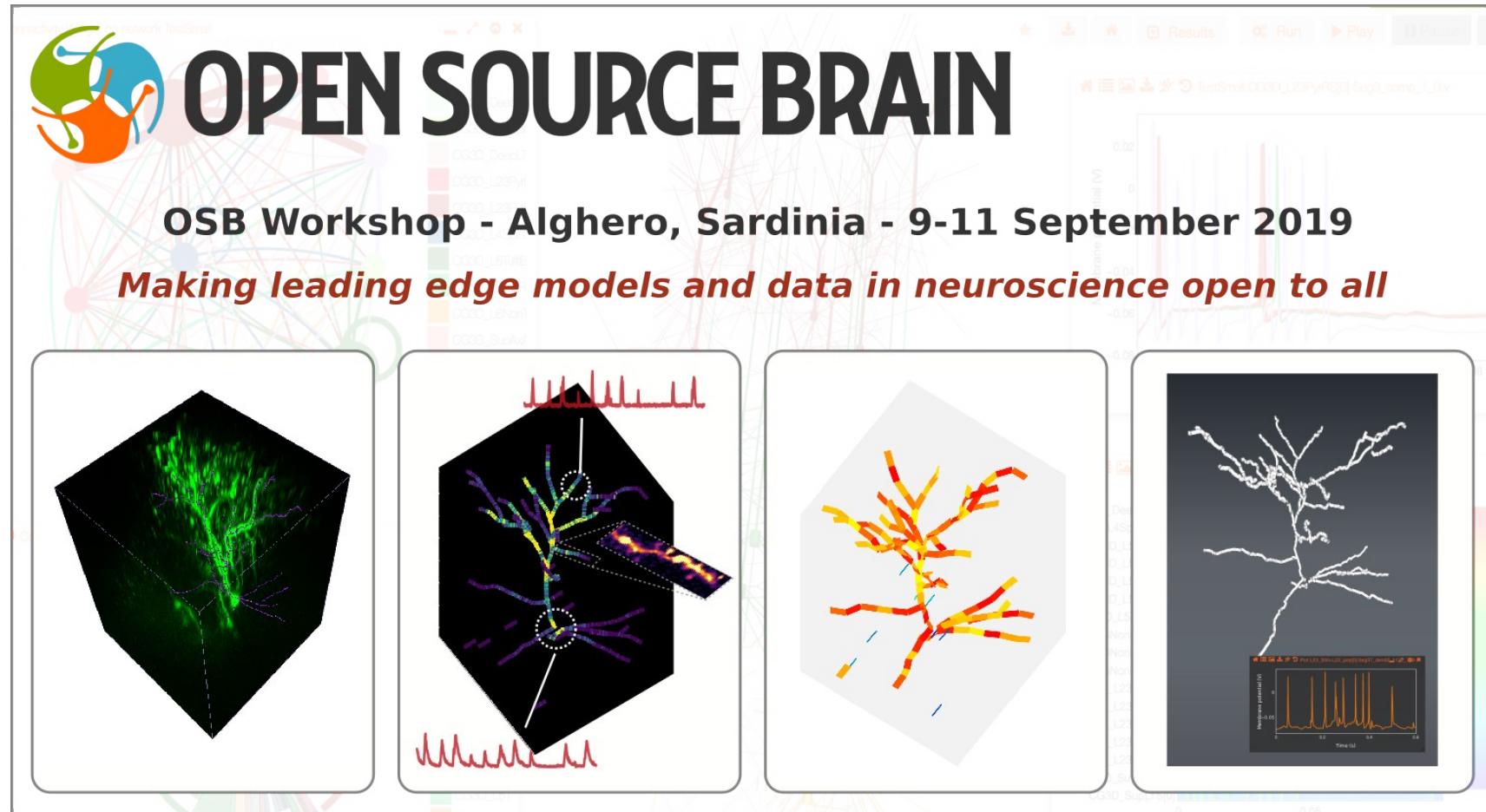


Welcome to the 2019 OSB workshop



OSB Organizers: **Padraig Gleeson**, Matt Earnshaw and Angus Silver
Local Organizer: Sergio Solinas



Towards a mechanistic understanding of brain function in health and disease

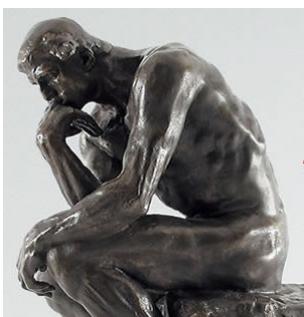
Sensations



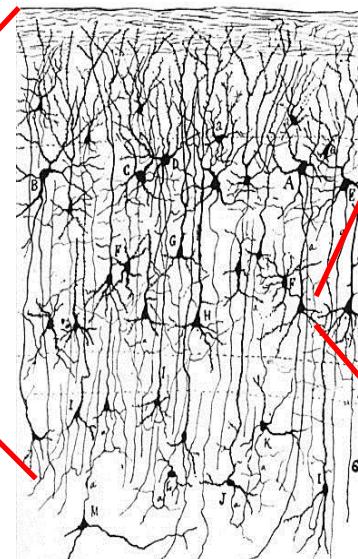
Actions



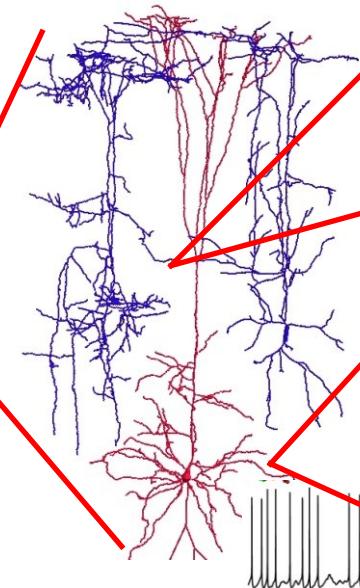
Cognition



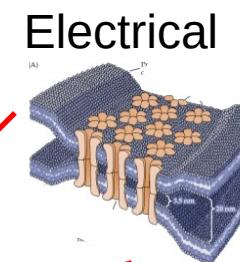
100 billion neurons
100 trillion synapses



Specialized
networks



Neuronal
classes

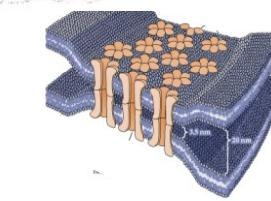
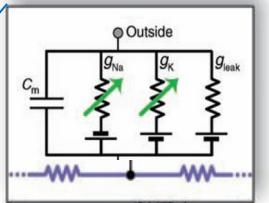
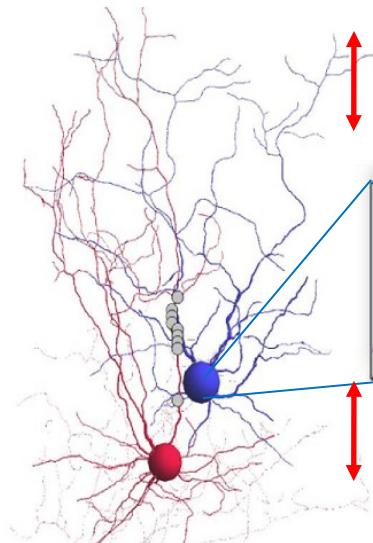
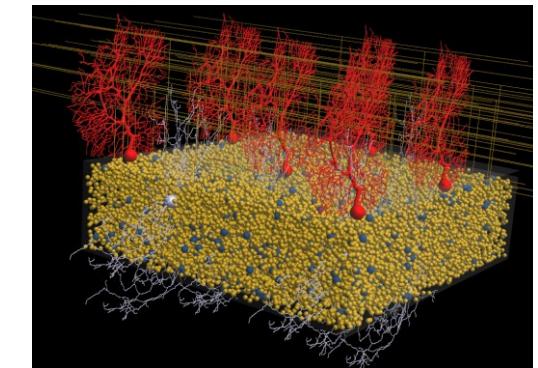
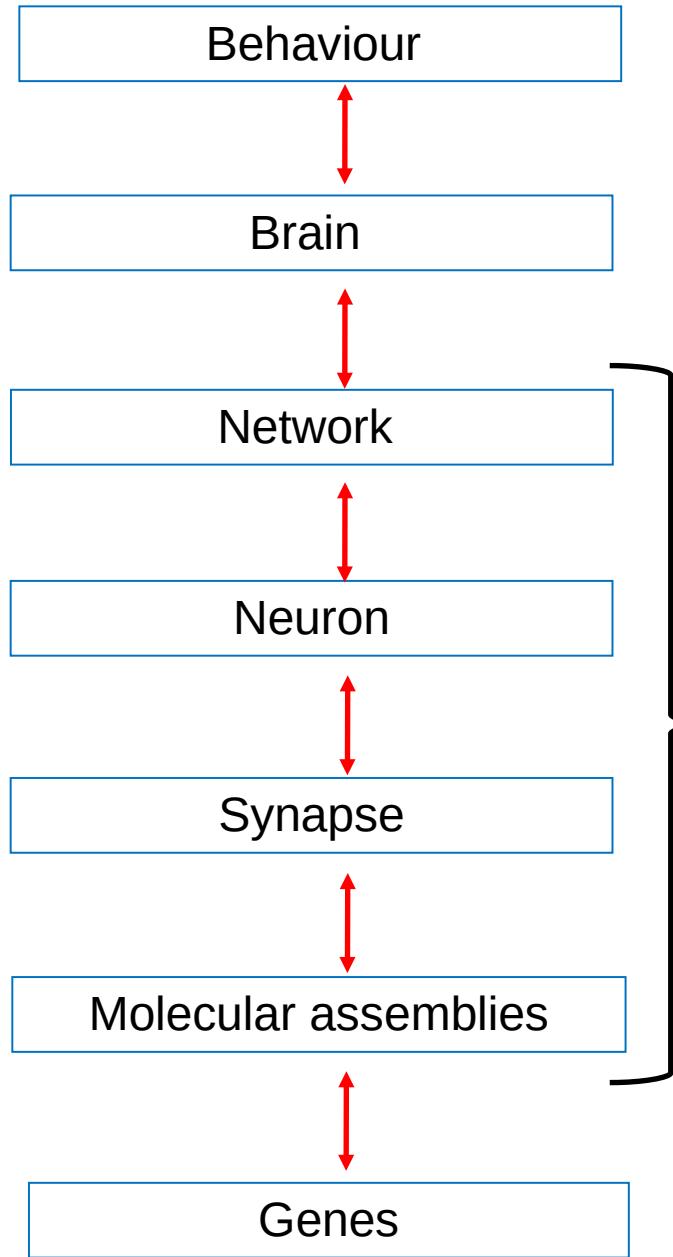


Synaptic
types

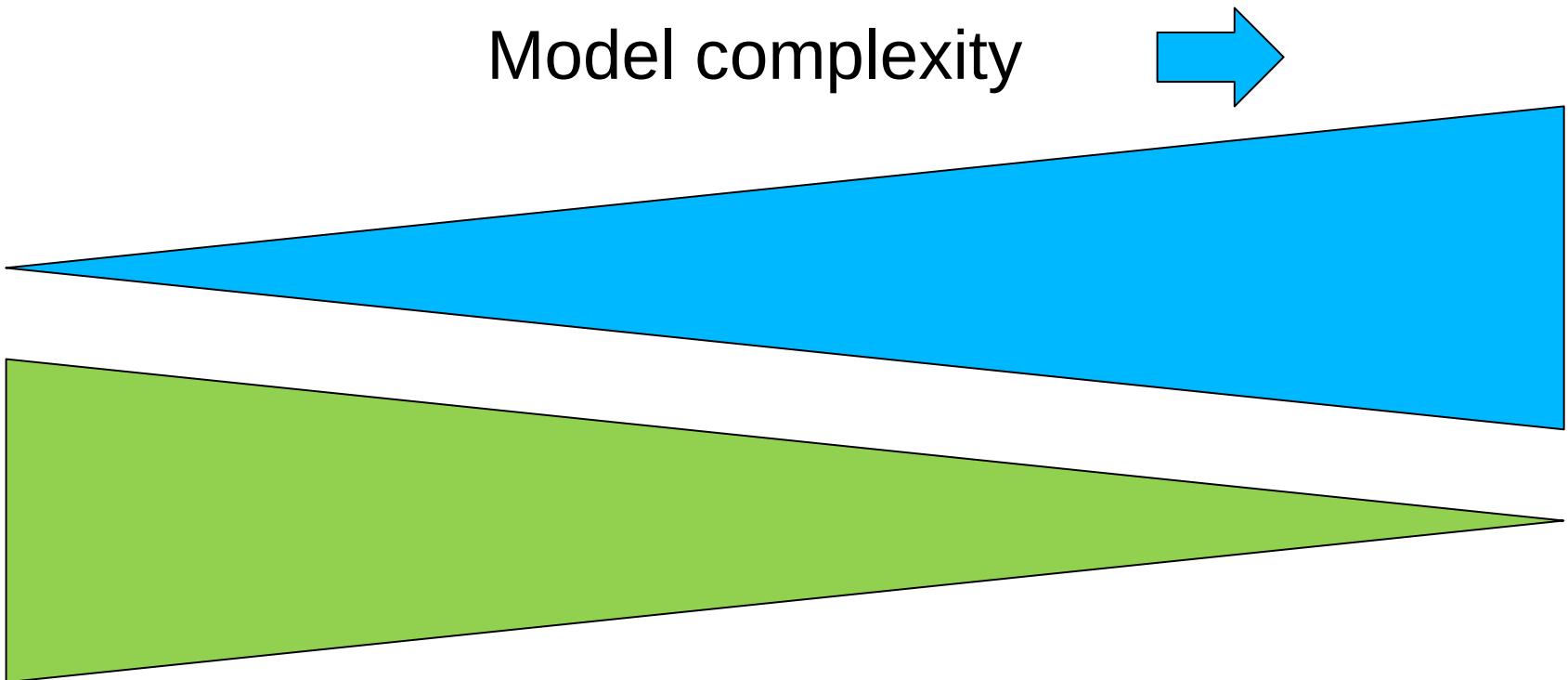
Why use models in neuroscience?

- 1) Formalize a hypothesis and test whether it is physically plausible
- 2) Explore properties that are currently inaccessible to experimental approaches
- 3) Make predictions that can be tested experimentally
- 4) Distil the essence of a phenomena and identify general principles
- 5) Link and consolidate experimental discoveries across multiple scales

Models of brain function span multiple spatial scales



A scaling problem



Transparency, accessibility, reproducibility,
reuse....and utility as a scientific tool

Neuroinformatics challenges of modeling complex neural systems

- **Implementation:** Large size & complex nature of code bases require management and testing to avoid bugs, which can be difficult to identify.
- **Reproducibility:** In practice it is often difficult to reproduce results reported in papers.
- **Transparency & Accessibility:** The specialized nature of software and hardware technologies acts as barriers to critical evaluation of model implementation by other scientists.
- **Reuse:** Models are built to answer specific question and are difficult to modify to address a new scientific question.

Potential neuroinformatics solutions

- 1. Modular descriptions of model components
 - 1. Automated testing frameworks
 - 1. Standardized model description languages that contain all necessary information (e.g. NeuroML, pyNN)
 - 1. Automated visualization of model structure and function
 - 1. A framework for deeper collaboration between experimental and computational neuroscience

Open Source Brain: a collaborative resource for visualizing, analyzing, simulating and developing standardized models of neurons and circuits



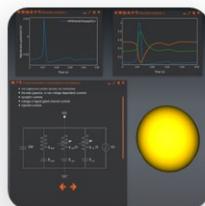
Modelling the brain, together

Open Source Brain is a resource for sharing and collaboratively developing computational models of neural systems.

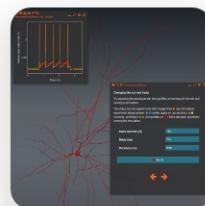
Learn more about the
OSB interface



Learn about the
Hodgkin Huxley model



Simulate
electrophysiologically
detailed cell models



Explore more OSB
projects



Or create an account to add your own models and **run simulations!**

[Sign up](#)

[Sign in](#)



The **Open Source Brain paper** has just been published in Neuron! Read [Gleeson et al. 2019](#).

Join us at the **OSB 2019 meeting** in Sardinia in September! More details [here](#).

[Follow @OSBTeam](#) 1,432 followers

[Help](#) · [Research Themes](#) · [About](#)

The Open Source Brain Initiative 2019. Website powered by Redmine

Supported by



ENG
04-Sep-19



OPEN SOURCE BRAIN



wellcome trust

Open Source Brain: a collaborative resource for visualizing, analyzing, simulating and developing standardized models of neurons and circuits

The screenshot displays the Open Source Brain (OSB) web application interface. At the top, there is a navigation bar with the OSB logo, a search bar, and links for "Explore OSB", "Sign in", and "Sign up". Below the navigation bar is a toolbar with various icons for connectivity, model description, cell visualization, and control buttons for results, run, play, pause, stop, and help.

A large central area shows a 3D reconstruction of a hippocampal CA1 pyramidal cell morphology, rendered in yellow. A tooltip window titled "Information for CA1" provides details about the cell type and its properties. The tooltip includes:

- Cell:** CA1
- Description:** Cell exported from NEURON ModelView in NeuroML Level 2 format and imported into neuroConstruct. The densities of hd, kap, kad have been replaced with variable mechanisms recreating the densities as used in the original model from ModelDB.
- Ion channels:** hd | hd_vhalfmin73 | hmin73 | kad | kap | kdr | na3_ar1 | nax | pas | na3 |
- Actions:** Click to apply colouring to the cell morphology
Highlight Cell Regions | Highlight hmin73_ModelViewParmSubset_7 |
Highlight hd_ModelViewParmSubset_5 | Highlight hd_vhalfmin73 |
Highlight na3_ar1 | Highlight kap | [Highlight kap_dendrite_group](#) |
[Highlight kad_dendrite_group](#) | [Highlight nax](#) |

To the right of the cell visualization, a "Description" panel provides a detailed scientific summary of the model, mentioning its source (M. Migliore, M. Ferrante, G.A. Ascoli (2005)) and how it simulates action potential propagation in oblique dendrites. It also links to the original OSB project.

At the bottom of the screen, a status bar shows the URL "184.72.223.204:8080/geppetto?load_project_from_id=5#", system tray icons, and the system time "6:14 PM 15-Sep-16".

Open Source Brain: a collaborative resource for visualizing, analyzing, simulating and developing standardized models of neurons and circuits

OPEN SOURCE BRAIN search projects

My Projects Explore OSB Admin padraig

Thalamocortical network Traub et al. 2005

Connectivity Model Description

Information for DeepAxAx

Click to apply colouring to the cell morphology
Highlight cell regions (soma, dendrites, axon)

Color mapping:
naf2_a0_b0_c0_d0... 100 S/m² → 4000 S/m²
kc_fast 250 S/m²
kdr_fs 100 S/m² → 4000 S/m²
cal 1 S/m² → 2 S/m²
pas 0.4 S/m² → 10 S/m²

Run experiment

Experiment Name* TestSmall - net

Time Step (s)* 0.000025

Length (s)* 0.3

Simulator* Neuron on OSB

Number of Processors* 1

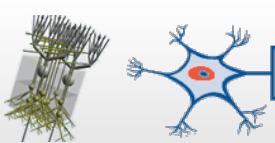
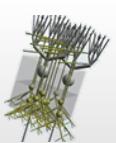
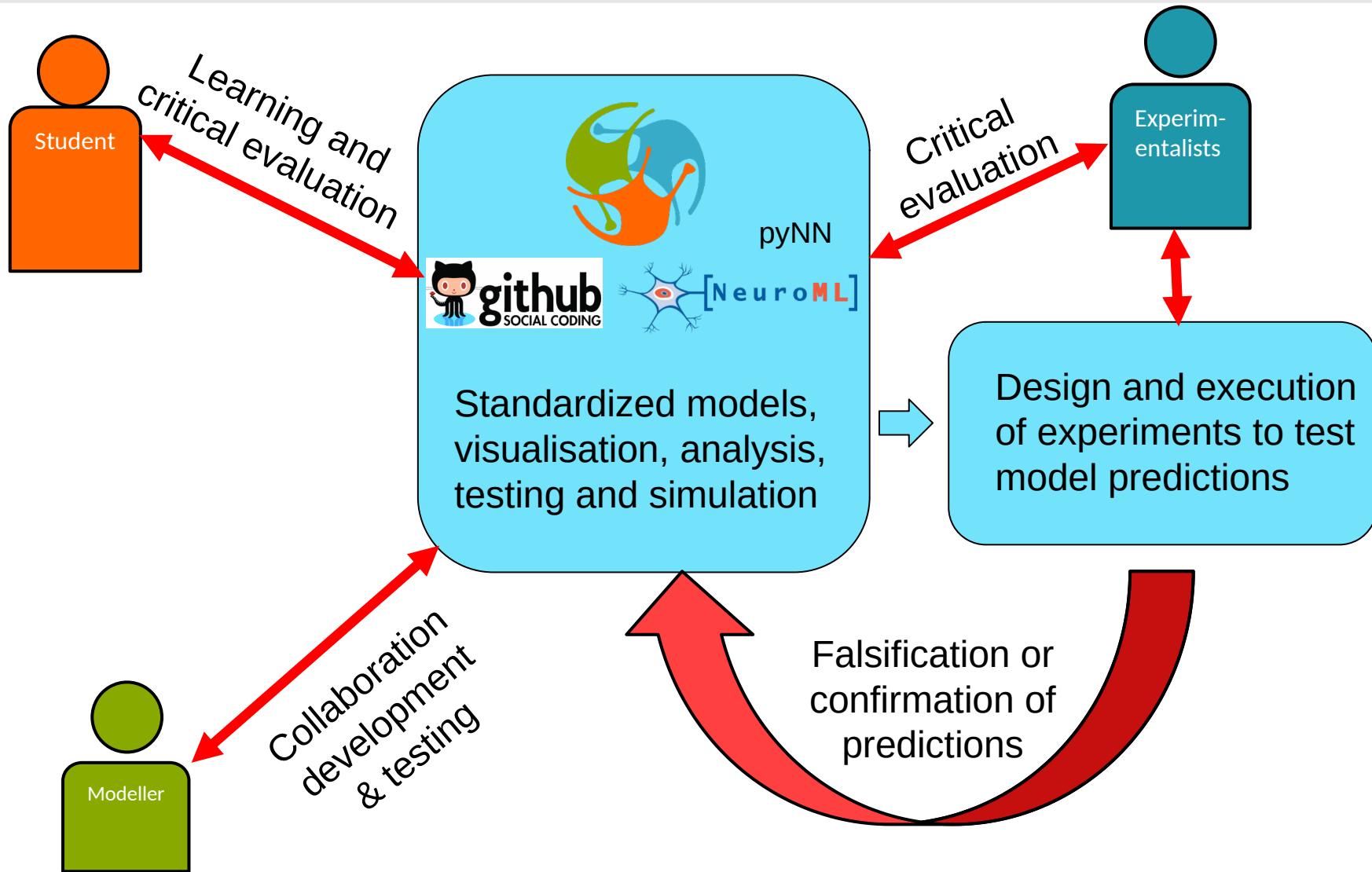
Connectivity Widget on network TestSmall

CG3D_De CG3D_De CG3D_De CG3D_L2' CG3D_L2' CG3D_L4' CG3D_L5' CG3D_L5' CG3D_L6' CG3D_Suj CG3D_Suj CG3D_Suj

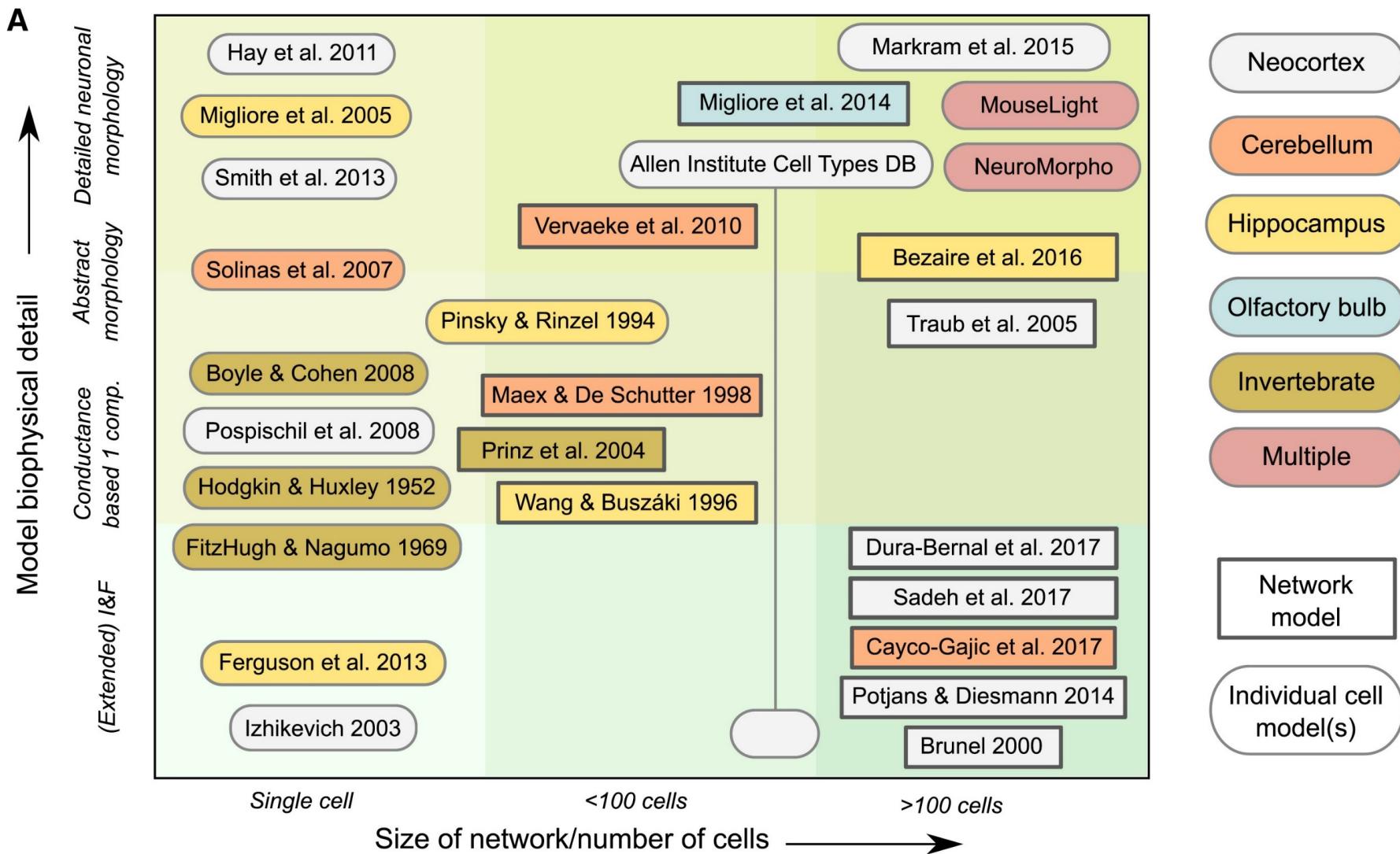
Membrane potential (V) Time (s)

Console Experiments

Current interactions on OSB and their relation to scientific workflow



OpenSourceBrain.org: where we are now



OpenSourceBrain.org: where we are now

Please cite this article in press as: Gleeson et al., Open Source Brain: A Collaborative Resource for Visualizing, Analyzing, Simulating, and Developing Standardized Models of Neurons and Circuits, *Neuron* (2019), <https://doi.org/10.1016/j.neuron.2019.05.019>

Neuron

NeuroResource

CellPress

Open Source Brain: A Collaborative Resource for Visualizing, Analyzing, Simulating, and Developing Standardized Models of Neurons and Circuits

Padraig Gleeson,¹ Matteo Cantarelli,^{1,2} Boris Marin,^{1,3} Adrian Quintana,¹ Matt Earnshaw,¹ Sadra Sadeh,¹ Eugenio Piasini,^{1,4} Justas Birgiolas,⁵ Robert C. Cannon,⁶ N. Alex Cayco-Gajic,¹ Sharon Crook,^{5,7} Andrew P. Davison,⁸ Salvador Dura-Bernal,⁹ András Ecker,^{1,10} Michael L. Hines,¹¹ Giovanni Idili,² Frederic Lanore,¹ Stephen D. Larson,¹² William W. Lytton,⁹ Amitava Majumdar,¹³ Robert A. McDougal,^{11,14} Subhashini Sivagnanam,¹³ Sergio Solinas,^{15,16} Rokas Stanislovav,¹ Sacha J. van Albada,¹⁷ Werner van Geit,¹⁰ and R. Angus Silver^{1,18,*}

¹Department of Neuroscience, Physiology and Pharmacology, University College London, London, UK

²MetaCell Limited, Oxford, UK

³Centro de Matemática, Computação e Cognição, Universidade Federal do ABC, Santo André, Brazil

⁴Computational Neuroscience Initiative and Department of Physics and Astronomy, University of Pennsylvania, Philadelphia, PA, USA

⁵School of Life Sciences, Arizona State University, Tempe, AZ, USA

⁶Annotate Software Limited, Edinburgh, UK

⁷School of Mathematical and Statistical Sciences, Arizona State University, Tempe, AZ, USA

⁸Unité de Neuroscience, Information et Complexité, Centre National de la Recherche Scientifique, Paris, France

⁹SUNY Downstate Medical Center and Kings County Hospital, Brooklyn, NY, USA

¹⁰Blue Brain Project, Ecole Polytechnique Federale de Lausanne (EPFL), Lausanne, Switzerland

¹¹Department of Neuroscience, Yale School of Medicine, New Haven, CT, USA

¹²OpenWorm Foundation, Boston, MA, USA

¹³University of California, San Diego, San Diego, CA, USA

¹⁴Center for Medical Informatics, Yale University, New Haven, CT, USA

¹⁵Department of Biomedical Science, University of Sassari, Sassari, Italy

¹⁶Institute of Neuroinformatics, University of Zurich and ETH Zurich, Zurich, Switzerland

¹⁷Institute of Neuroscience and Medicine (INM-6), Institute for Advanced Simulation (IAS-6) and JARA-Institut Brain Structure-Function Relationships (INM-10), Jülich Research Centre, Jülich, Germany

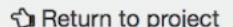
¹⁸Lead Contact

*Correspondence: a.silver@ucl.ac.uk

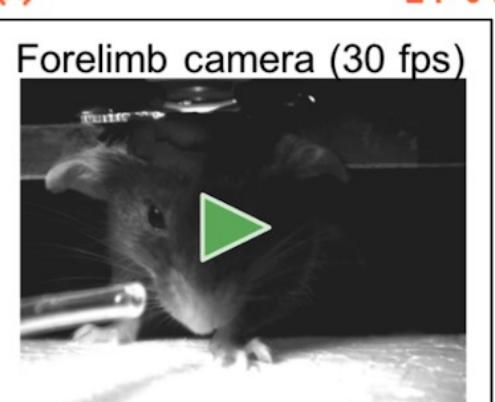
<https://doi.org/10.1016/j.neuron.2019.05.019>

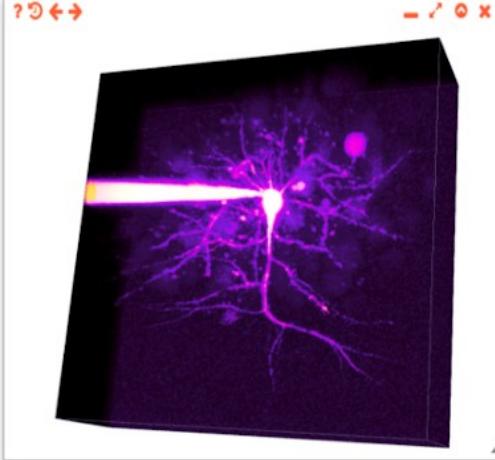
Future plans: bringing together standardized models and standardized multiscale data on OpenSourceBrain.org

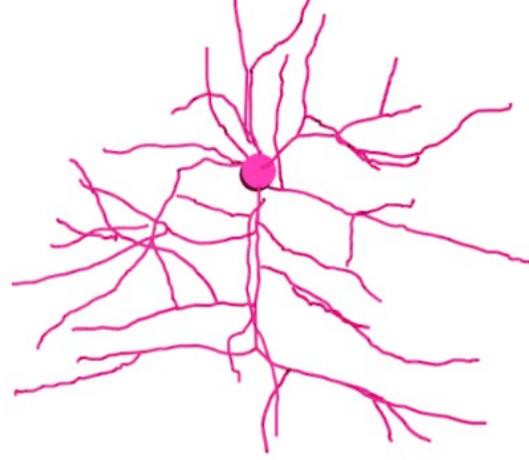
OPEN SOURCE BRAIN search projects 

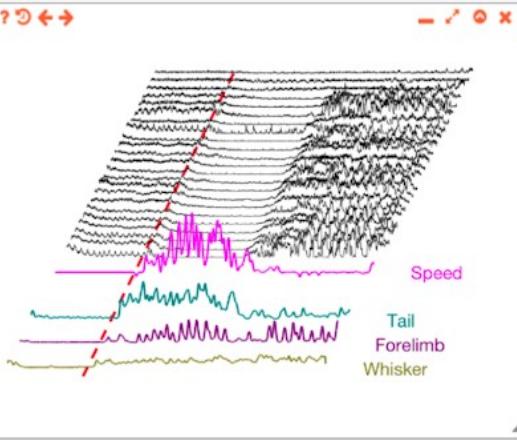
My Projects Explore OSB Admin padraig 

Silver Lab Data

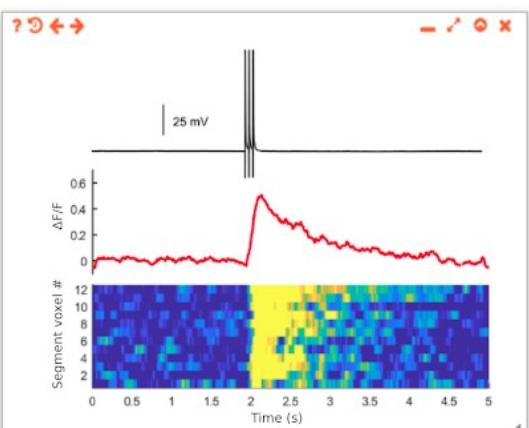
Forelimb camera (30 fps) 

3D reconstruction of a neuron 

3D reconstruction of a neuron (magenta) 

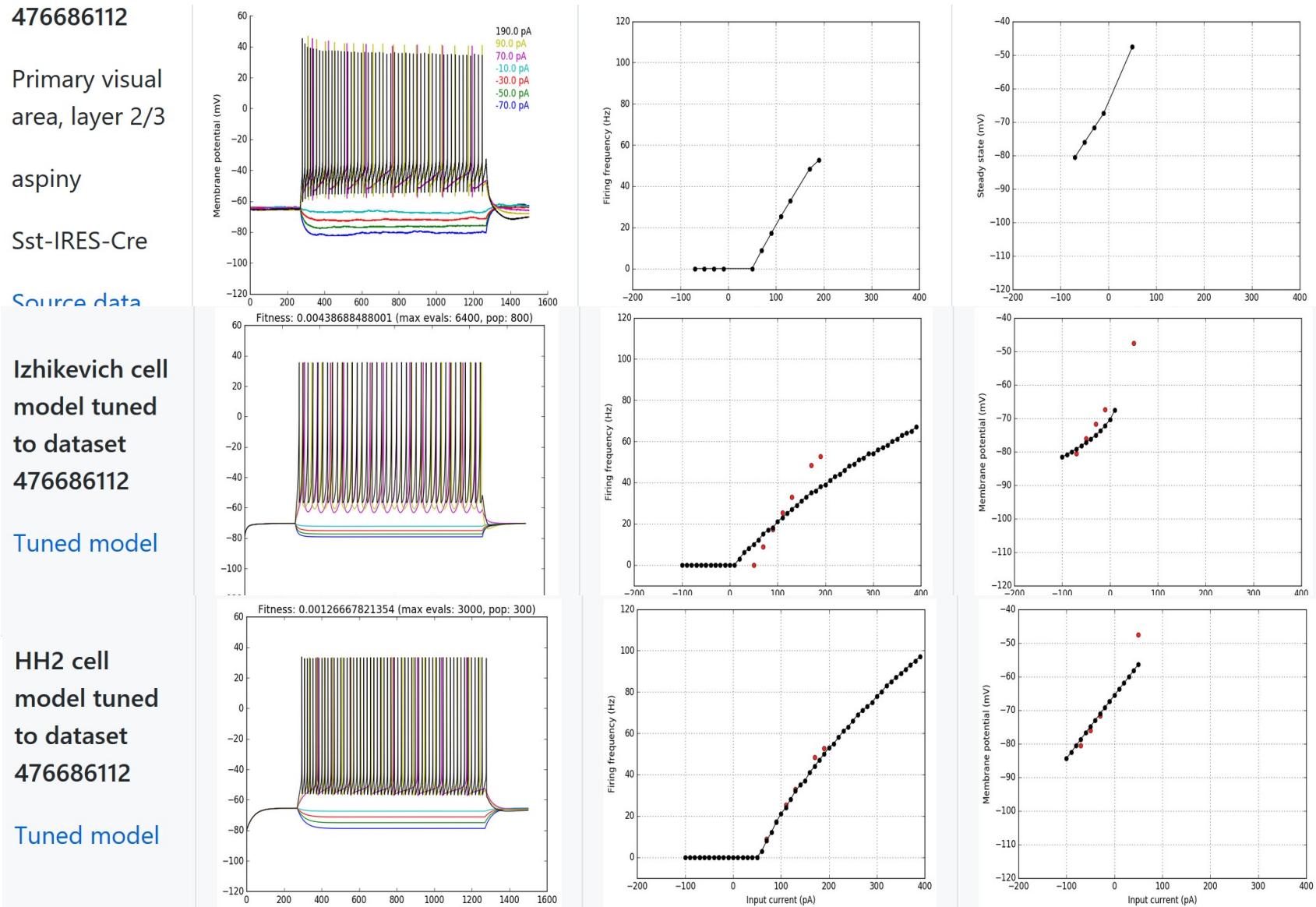
Speed, Tail, Forelimb, Whisker 

3D reconstruction of a neuron (colored) 

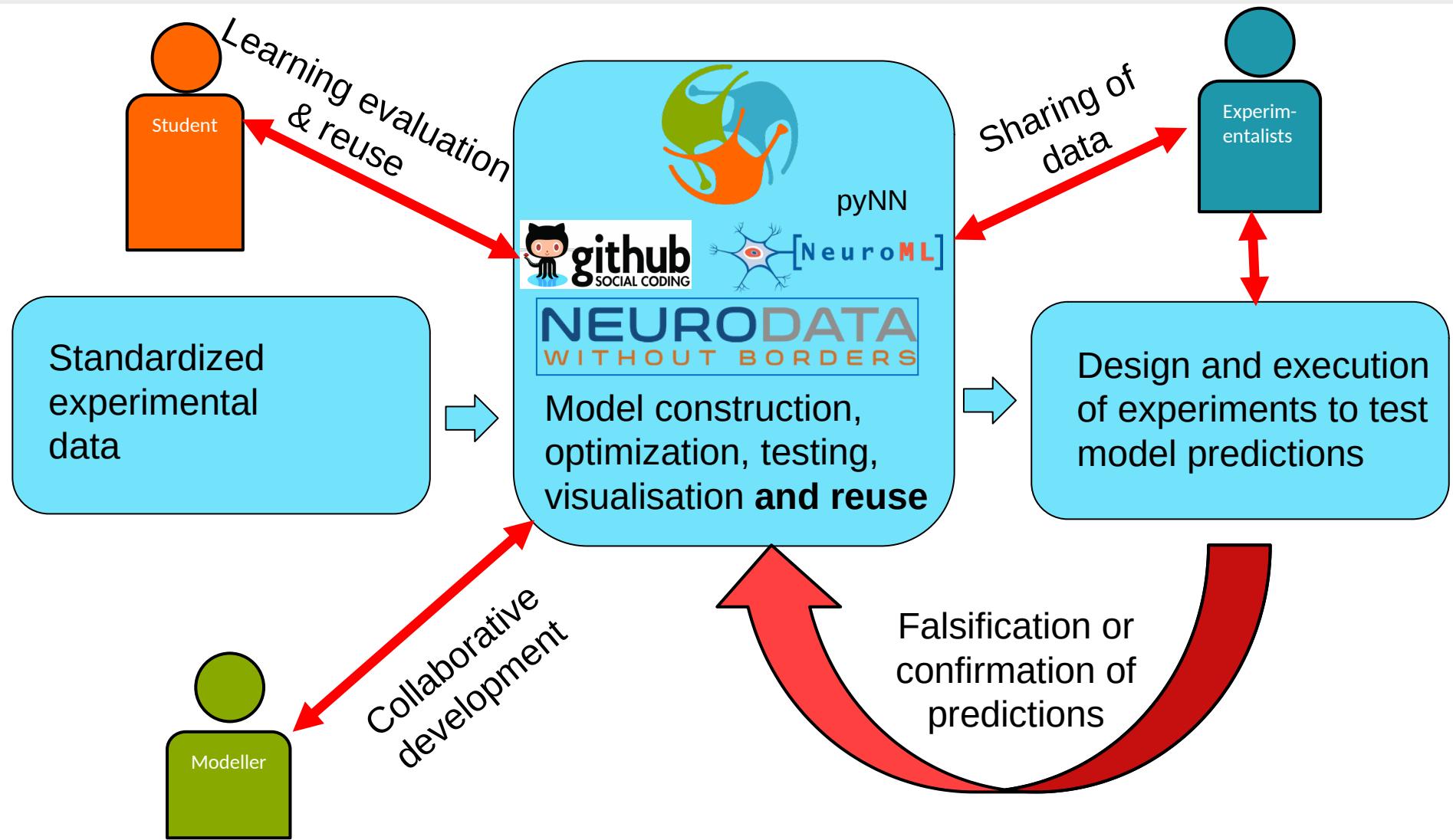
ΔF/F vs Time (s) 

Console Experiments 

Raw data provides ground truth information for refining and reusing models



Bringing together standardized data and models on OSB to facilitate reuse



3-day structure of workshop

Day 1: Building and sharing standardised neuronal models

>OSB, HBP, NeuroML, Geppetto, Channelpedia, and models

Day 2: Standardising and sharing experimental neuroscience data

>Imaging, electrophysiology and connectomes data, NeuroSEE, NWB:N and NWB Explorer .

Day 3: Investigating brain function across multiple scales

>Multiscale modelling, analysis of multiscale data and the Allen Brain Initiative,

Discussion sessions

Day 1: How do we make models more accessible and useful to scientists?

- > Are the current features of OSB, sufficient for you to switch to using it in your model development and dissemination?
- > How can OSB better interact with other initiatives in the field, e.g. HBP/Allen?
- > How can we facilitate model conversion to populate OSB with more models?
- > How can we lower the barrier for building new models and reusing existing components for new scientific questions?
- > What are the current limitations of NeuroML and PyNN?

Day 2: How can we make data sharing accessible and useful?

- > What are the key challenges in standardizing data so that it can be parsed/reused?
- > Are the proposed solutions to data standardization up to handling the size and heterogeneity of neuroscience data (e.g. behavioural analysis, high speed Ca²⁺ imaging, multi-channel electrophysiology, connectomics, genomics etc.)?
- > What are the key challenges in making data available?
- > What should be shared? Raw data, analysis, data points in figures?
- > Is sharing data worth the (considerable) effort - who will actually use it?

Day 3: How can we create better multiscale models of circuits?

- > Are multiscale models of the brain worth the effort?
- > What are the benefits of bringing multiscale models and the experimental data used to build and test them together?
- > What are the key challenges in linking model structure, optimization and testing to experimental data?
- > Do Python notebooks provide the right balance in the trade-off between accessibility and flexibility in model building/ data analysis for OSB infrastructure?

[Contribute discussion points on Google Doc](#)

Informal discussion sessions

Pool



Beach



Workshop dinner



Day 1: Building and sharing standardised neuronal models

Morning session

- 9:00 **Angus Silver** Welcome and Introduction to goals of meeting
9:10 **Padraig Gleeson** Open Source Brain and NeuroML
9:50 **Yann Zerlaut** An overview of the tools for modelling and simulation developed within the Human Brain Project

10:30 - 11:00 *Coffee break*

- 11:00 **Sharon Crook** NeuroML-DB: A model sharing platform to promote efficient model selection and reuse
11:30 **Rajnish Ranjan** A kinetic map of the homomeric voltage-gated potassium channel (Kv) family
12:00 **Boris Marin** Converting models to NeuroML

12:30 - 13:30 *Lunch*

Afternoon session

- 13:30 **Matteo Cantarelli** Geppetto: an open source platform to build neuroscience applications
14:15 **Ankur Sinha** NeuroFedora: Free software for Open Science
14:45 **Lightning talks** Bence András Lázár, Bettina Kata Kádár, Csaba Kazinczi (University of Szeged)

15:00 - 15:30 *Coffee break*

15:30 - 17:00 **Discussion session:** *How do we make models more accessible and useful to scientists?*

Day 2 – OSB 2019

Standardising and sharing experimental neuroscience data

Experimental neuroscience data is heterogeneous, multiscale and analysis is complex

Increasing spatial scale and complexity
↓

Anatomy

Receptor Immuno-histochemistry

Neuronal morphologies

Brain mapping & Connectomes

Electrophysiology

Single/ensemble channel recordings

Whole cell patch-clamp recordings

Multielectrode array

Functional imaging

Synaptic imaging

Single cell imaging

Population imaging

Behaviour

Restricted task

Freely moving

Natural environment

How can we structure neuroscience data to facilitate reuse?

Day 2: Standardising and sharing experimental neuroscience data

Morning session

- 9:00 **Angus Silver** Introduction to session
9:05 **Diego Restrepo** Shedding light on the involvement of the cerebellum in associative learning
9:50 **Simon Schultz** NeuroSEE: a pipeline for processing and analysing data from multiphoton fluorescence brain imaging experiments

10:35 - 11:00 Coffee break

- 11:00 **Jeff Diamond** The Blind Men and the Retina: Community Connectomics Prior to Automated Segmentation
11:45 **Oliver Rübel** NWB:N 2.0: An Ecosystem for Neurophysiology Data Standardization

12:30 - 13:30 Lunch

Afternoon session

- 13:30 **Matteo Cantarelli & Filippo Ledda** NWB Explorer: visualize and understand neurophysiology data
13:50 **Ian Duguid** Towards a systems level understanding of volitional motor control: approaches and challenges in data acquisition, management & sharing
14:35 **Alex Cayco-Gajic** Population imaging and dimensionality analysis of cerebellar axons

15:05 - 15:30 Coffee break

15:30 - 17:00 **Discussion session:** *How can we make data sharing accessible and useful?*

18:00 **Bus to conference dinner** Pedramare restaurant

Day 3 – OSB 2019

Investigating brain function across multiple scales

OSB



search projects



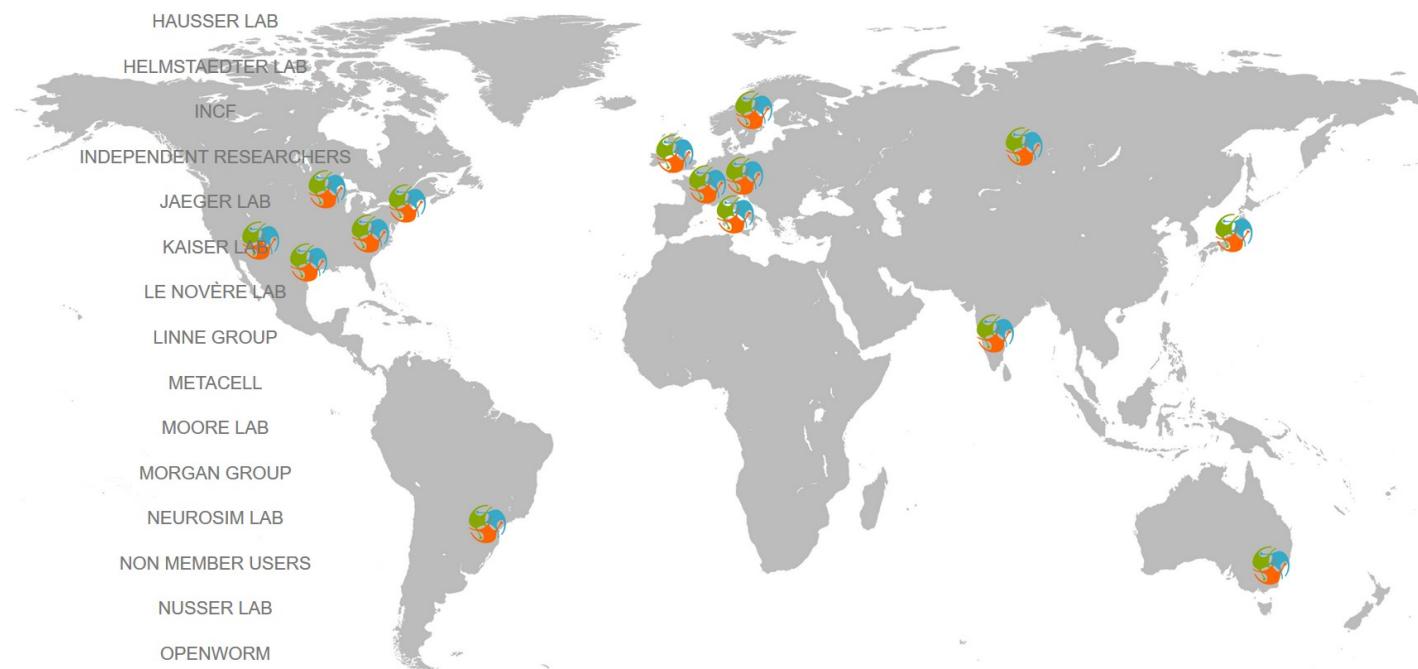
Explore OSB

Help

Sign in

Sign up

1003 Members 52 Research groups 178 Projects



Type here to search



7:00 AM
11-Sep-19

Towards a mechanistic understanding of brain function in health and disease

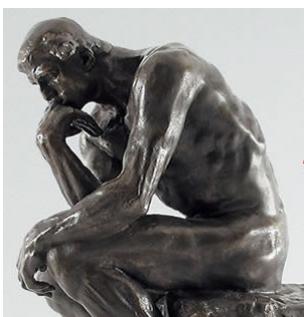
Sensations



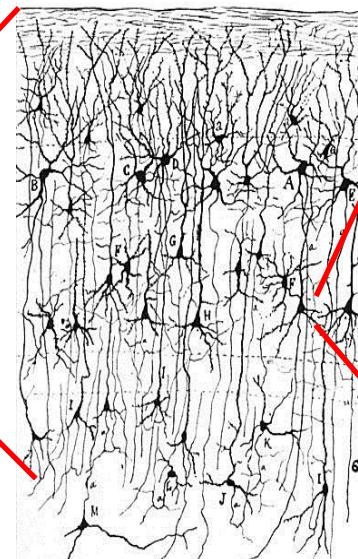
Actions



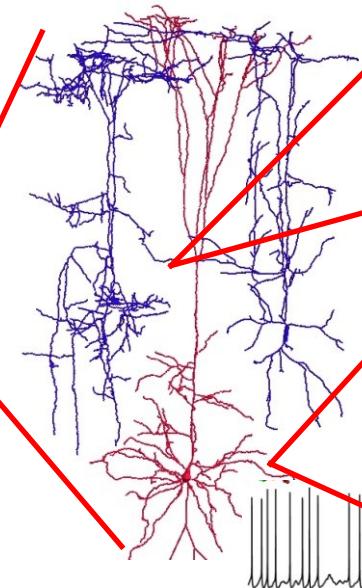
Cognition



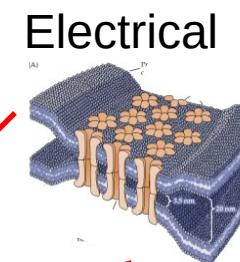
100 billion neurons
100 trillion synapses



Specialized
networks

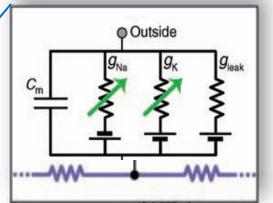
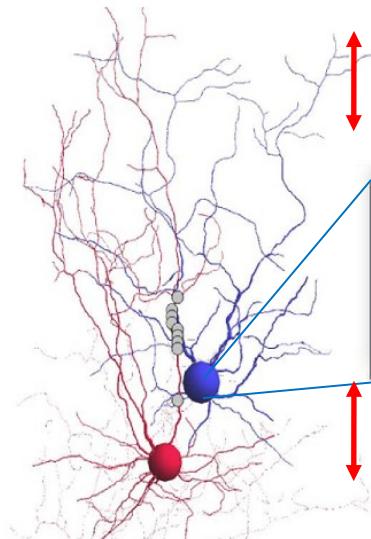
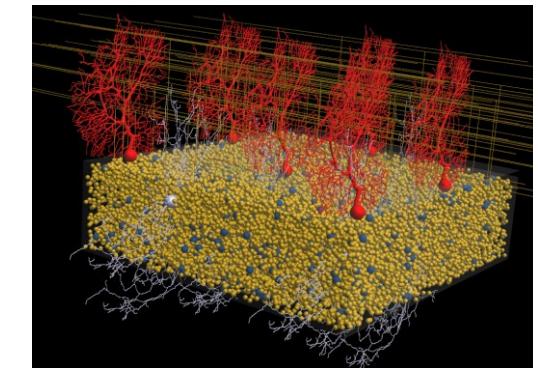
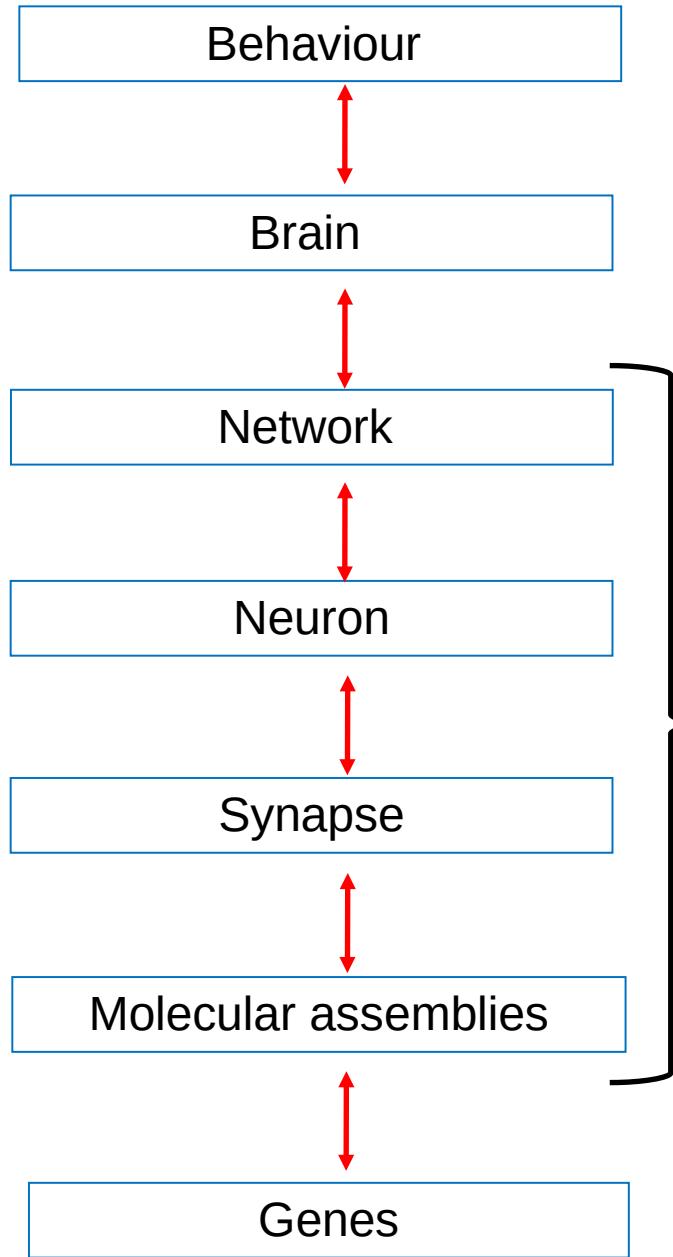


Neuronal
classes



Synaptic
types

Models of brain function span multiple spatial scales



Day 3: Investigating brain function across multiple scales

Afternoon session

9:00 **Jan Fousek**

The Virtual Brain

9:45 **Sacha van Albada**

Large-scale spiking neural network modeling of primate cerebral cortex

10:30 - 11:00 Coffee break

11:00 **Yazan Billeh**

Large-scale Datasets and Modeling Tools from the Allen Institute for Brain Science

11:45 **Fleur Zeldenrust**

Understanding information transfer in the brain: from single cell to network

12:15 **Sergio Solinas**

The NeuroAgents ERC project

12:30 - 13:30 Lunch

Afternoon session

13:30 **Oren Amsalem**

microcircuit

Cellular mechanisms of auditory surprise in faithful computer replica of cortical

14:00 **Harsha Gurnani** Impact of heterogeneity on the dynamics of a NeuroML-based circuit model

14:30 - 15:00 Coffee break

15:00 **Padraig Gleeson**

Creating cortical models across scales in NeuroML

15:30 - 17:00 **Discussion session:** How can we create better multiscale models of circuits?

17:30: End of meeting