

Calcium Imaging Subgroup

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Collaborative data pipelines

Community

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Mesoscale Activity Project

International Brain Lab

Princeton U19

UCSD U19

Tolias Lab, Baylor College of Medicine

Reimer Lab, Baylor College of Medicine

Sinz Lab, Wilhelm Schickard Institute for Computer Science

Berens Lab, Werner Reichardt Centre for Integrative Neuroscience

Euler Lab, Werner Reichardt Centre for Integrative Neuroscience

Bethge Lab, Werner Reichardt Centre for Integrative Neuroscience

Shcheglovitov Lab, University of Utah

Moser Group, Kavli Institute for Systems Neuroscience

Mouse Motor Lab, Rowland Institute at Harvard University

Harvey Lab, Harvard Medical School

Smirnakis Lab, Harvard Medical School

Angelaki Lab, New York University

McGinley Lab, Baylor College of Medicine

Seung Lab, Princeton University

Siapas Lab, California Institute of Technology

Svoboda Lab, Janelia Research Campus

Busse Lab, Ludwig-Maximilians-Universität München

Katzner Lab, Ludwig-Maximilians-Universität München

Engel Lab, Cold Spring Harbor Laboratory

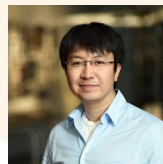
Tuthill Lab, University of Washington

Applied Physics Lab, Johns Hopkins University

Mesoscale Activity Map

SIMONS FOUNDATION

Multi-regional Neuronal Dynamics of Memory-Guided Flexible Behavior



Nuo Li



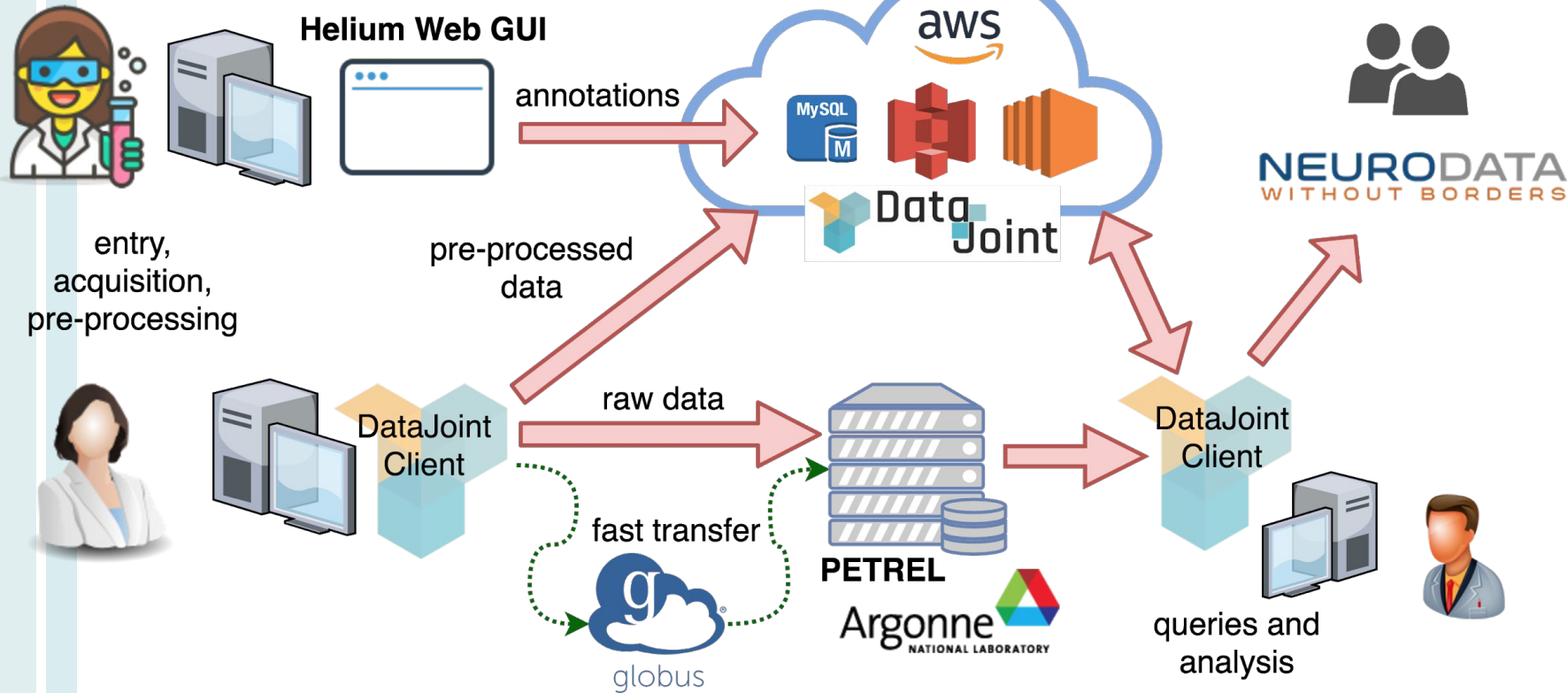
Karel Svoboda



Shaul Druckmann



Xiao-Jing Wang



Coordinating multiple experimental modalities

Complex, structured behaviors

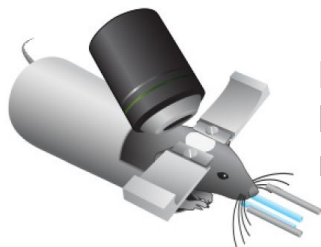
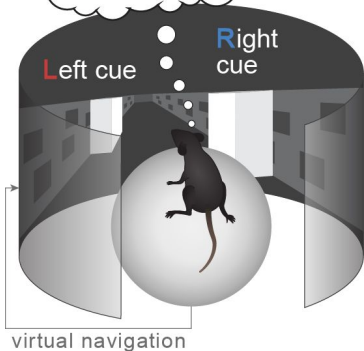
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Multiple neural imaging / perturbation methods

Anatomical registration

Mouse, virtual reality

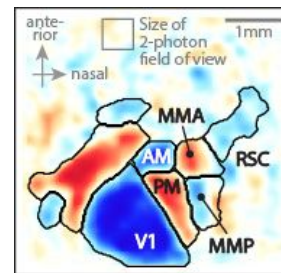
Total #R > #L?
↓
Turn right



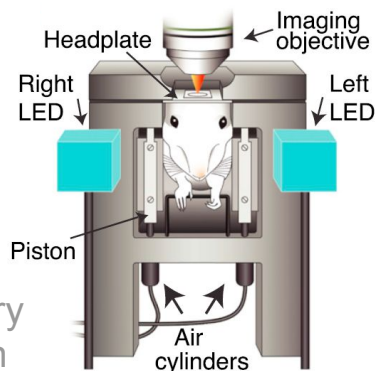
Mouse, body restrained

Cellular resolution

Mesoscale (dorsal cortex)



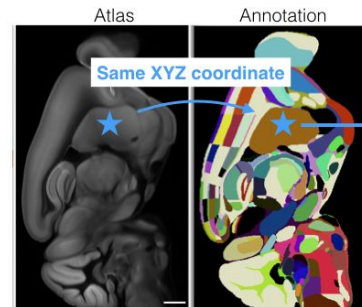
Retinotopy mapping



Rat, voluntary head-fixation

Brain clearing + lightsheet microscopy

Registration to common brain atlas



Steps for processing calcium imaging data

Data Storage/Organization

- Local
- Cloud (e.g., Drive/Dropbox)
- Database (e.g., Datajoint)

Motion correction

- Cross-correlation, Moco, etc
- Ratiometric imaging w red/green fluorophores

Alignment to standard brain/ventral nerve cord for correspondence w/ confocal/EM data

- Computational Morphometry Toolkit (CMTK)
- nBlast (for matching neural morphologies)

Data Segmentation

- None (sparse driver lines)
- Clustering pixel correlations
- PCA/ICA, NNMF, etc

Signal deconvolution

- Spikefinder, Genie, NND, etc
- None (in most neurons, firing rates are too high and fluctuate too rapidly to extract spikes from GCamp data)

Analysis

- Custom code in Python or Matlab

Data Storage/Organization

- Cost
- Unwieldiness

Motion correction

- Lack of effective methods for correcting anisotropic tissue deformation

Alignment to standard brain/ventral nerve cord for correspondence w/ confocal/EM data

- Technically challenging for many labs

Data Segmentation

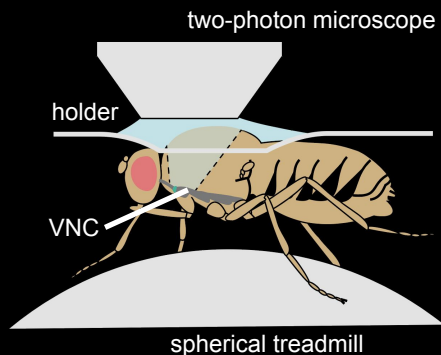
- Lack of flexible algorithms/toolboxes

Segmentation tools are optimized for extracting signals from cell bodies in mammalian cortex. In most cases, we want to image from axons/dendrites (this is not fly specific).

Analysis

- Each experiment/dataset is slightly different and requires bespoke analysis

A typical 2-photon imaging experiment in behaving *Drosophila* (FlyLoops U19)

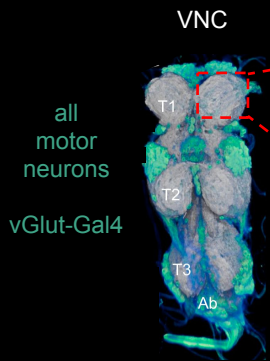


raw video (single view)



Video for tracking behavior
Up to 6 cameras @ 300-400 fps
~500 GB raw data / hr

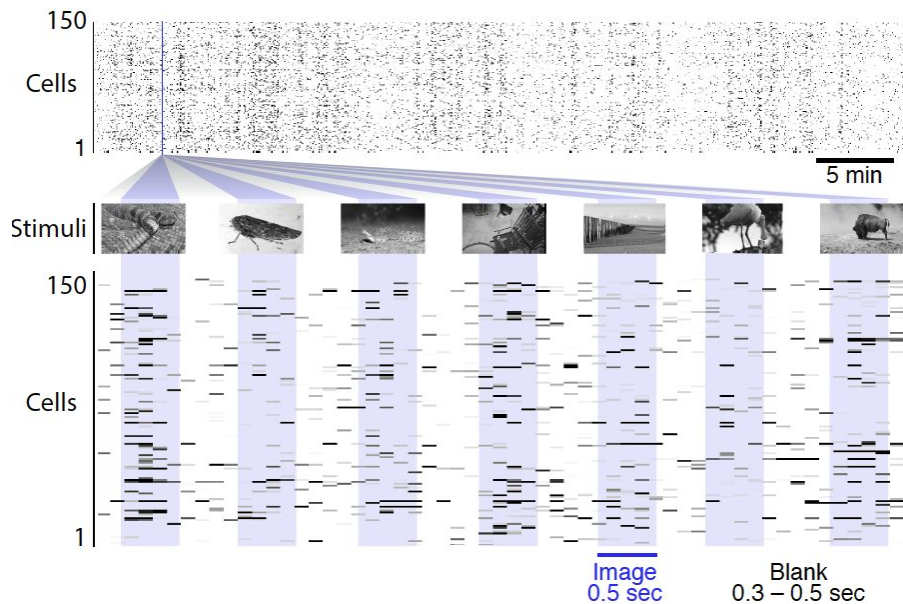
raw imaging data (single plane)



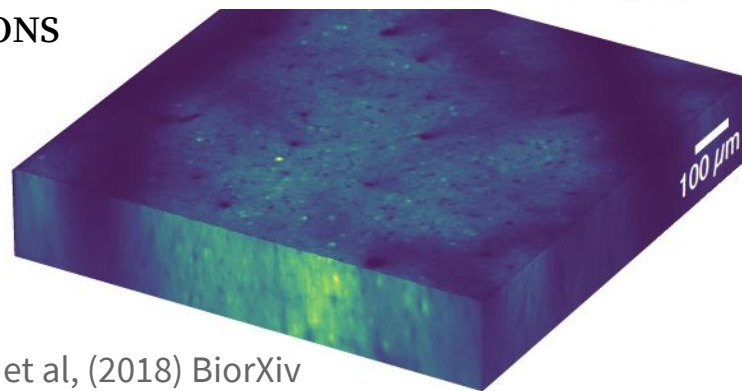
Volumetric 2-photon imaging
30 fps, 4 z-planes
~250 GB raw data / hr

Complexity

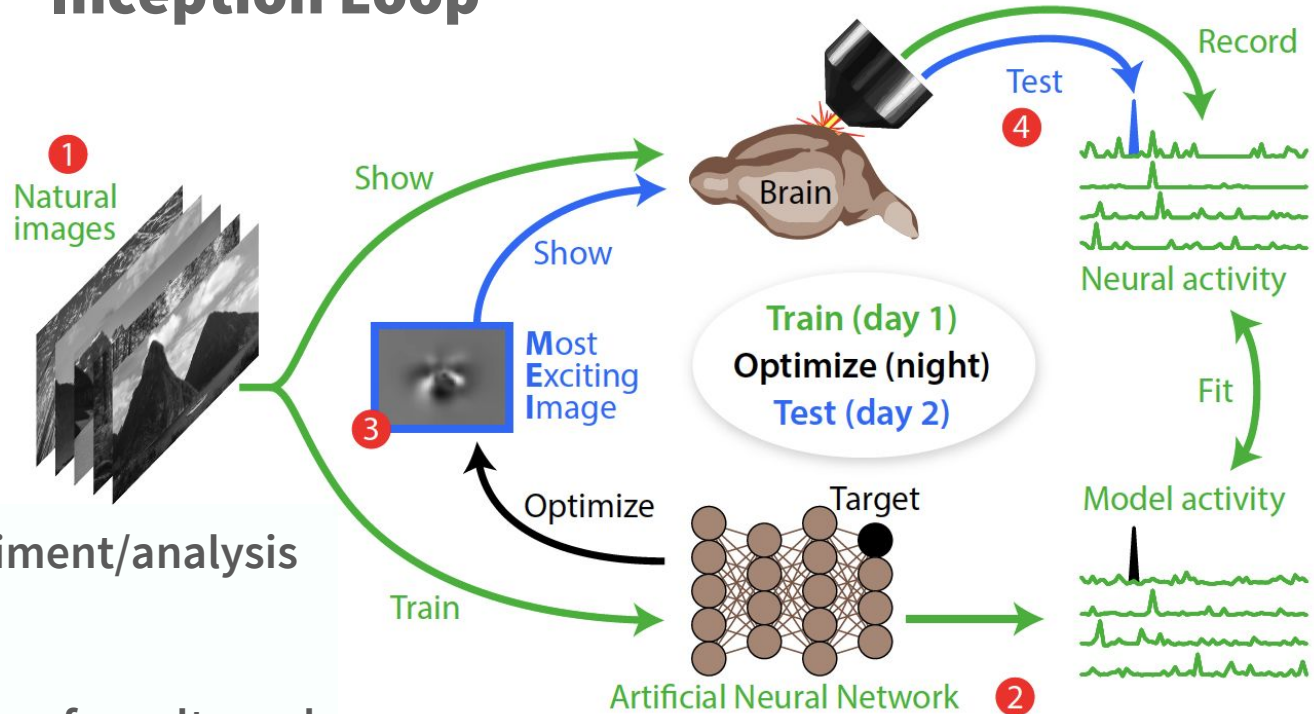
- ❖ 20,000 cells per session \times multiple days
= 100,000 unique cells = 1 million
neuron-hours from one animal.
- ❖ Multi-modality: Behavior + Visual
stimulation + Anatomical
- ❖ Quality control: eye closing, brain state,
optical quality, movement
- ❖ Sandbox testing vs. real life



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Inception Loop

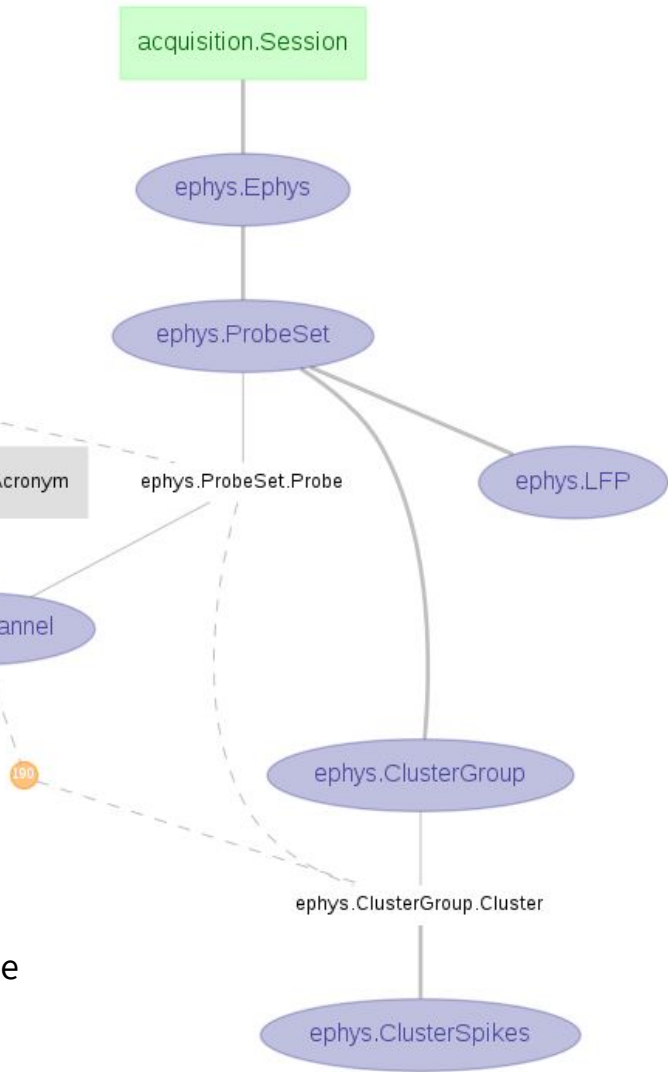


Fast experiment/analysis
cycle

Traceability of results and
parameters

Walker, Sinz, et al, (2018) BiorXiv

Canonical Pipelines



Data pipelines quickly become overly complex with lab-specific detail

New projects need fully-functional minimal starting points

Project: minimal but fully-functional data pipelines

Thank you