CATMAID

COLLABORATIVE NEURON TRACING, ANALYSIS AND DATA SHARING

Albert Cardona & Tom Kazimiers

NEUBIAS Academy, February 3 2021

Visualizing, Sharing and Annotating Large Image Data “in the Cloud”

WHO WE ARE

Albert Cardona, Group Leader for Experimental and Comparative Connectomics at MRC LMB (UK)

Tom Kazimiers, Main Developer of CATMAID, Open Source Research Software Engineer at kazmos GmbH (DE)

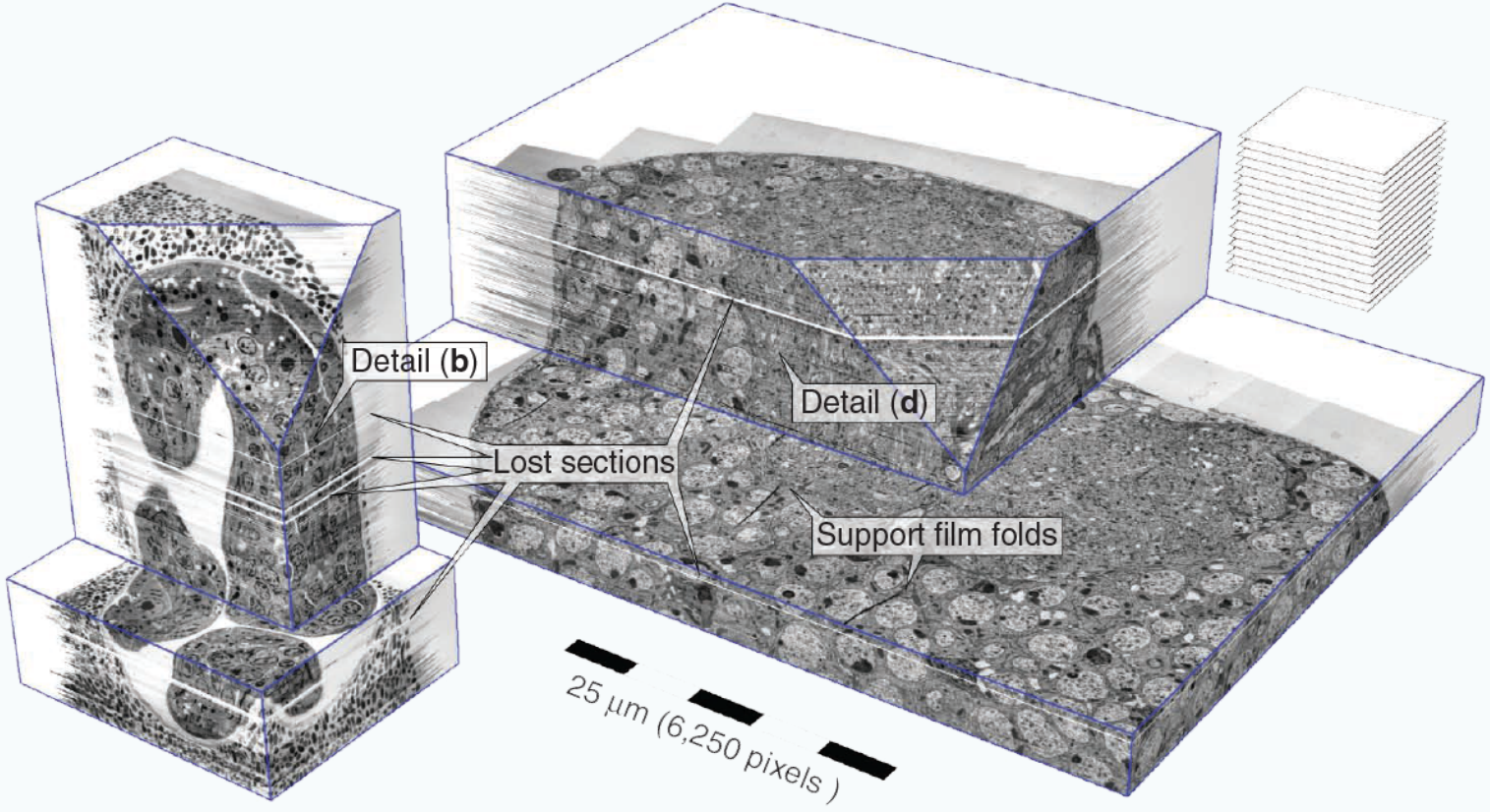
OUTLINE

- (Big) Data "in the cloud"
-  overview
- Public servers, accounts, projects
- Working with LM data
- Collaborative tracing in EM and common tools

(BIG) DATA "IN THE CLOUD"

- Online resources, data served from other computers
- Often optimized for fast parallel random reads
- Usually dataset sizes of many TB, copying hard
- Access from lower-spec devices
- Potentially harder to set-up

SSTEM IMAGE DATA



S. Saalfeld, R. Fetter, A. Cardona, *et al.*, "Elastic volume reconstruction from series of ultra-thin microscopy sections," *Nature Methods*, 2012

REPRESENTATIVE DATASETS

- **Drosophila Larva L1 Dataset (ssTEM)**:
  28,128 x 31,840 x 4,841 px @ 3.8 x 3.8 x 50 nm/px
  0.9TB as JPEG tiles (512 x 512)
- **Drosophila FAFB Dataset (ssTEM)**:
  253,952 x 155,648 x 7,063 px @ 4 x 4 x 40 nm/px
  10.9TB as JPEG tiles (1024 x 1024)
- **Drosophila Hemibrain Dataset (FIBSEM)**:
  40,959 x 34,815 x 43,007 px @ 8 x 8 x 8 nm/px
  5.3TB as Neuroglancer Precomputed (64 x 64 x 64)

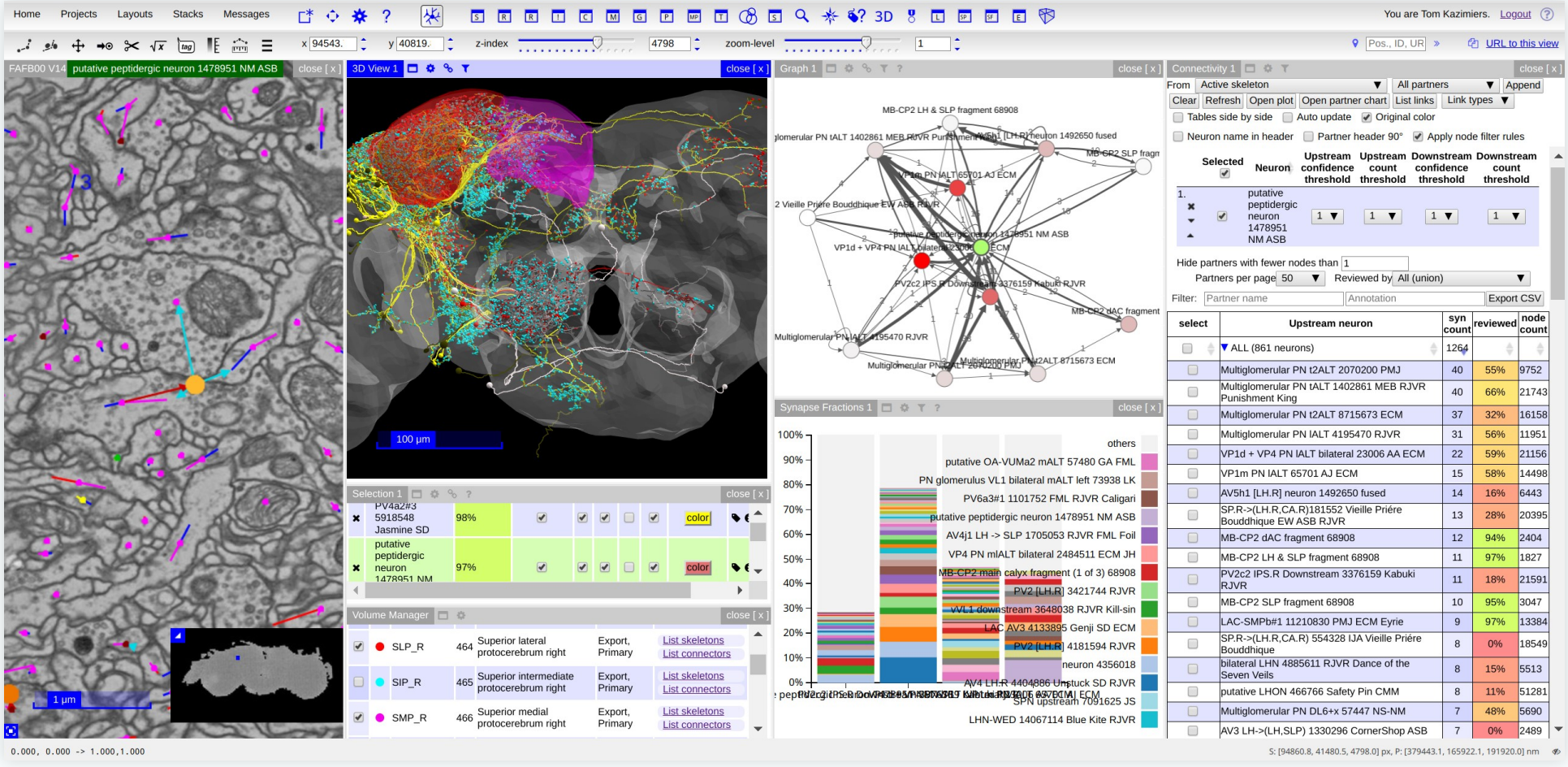
CATMAID

Collaborative Annotation Toolkit

for

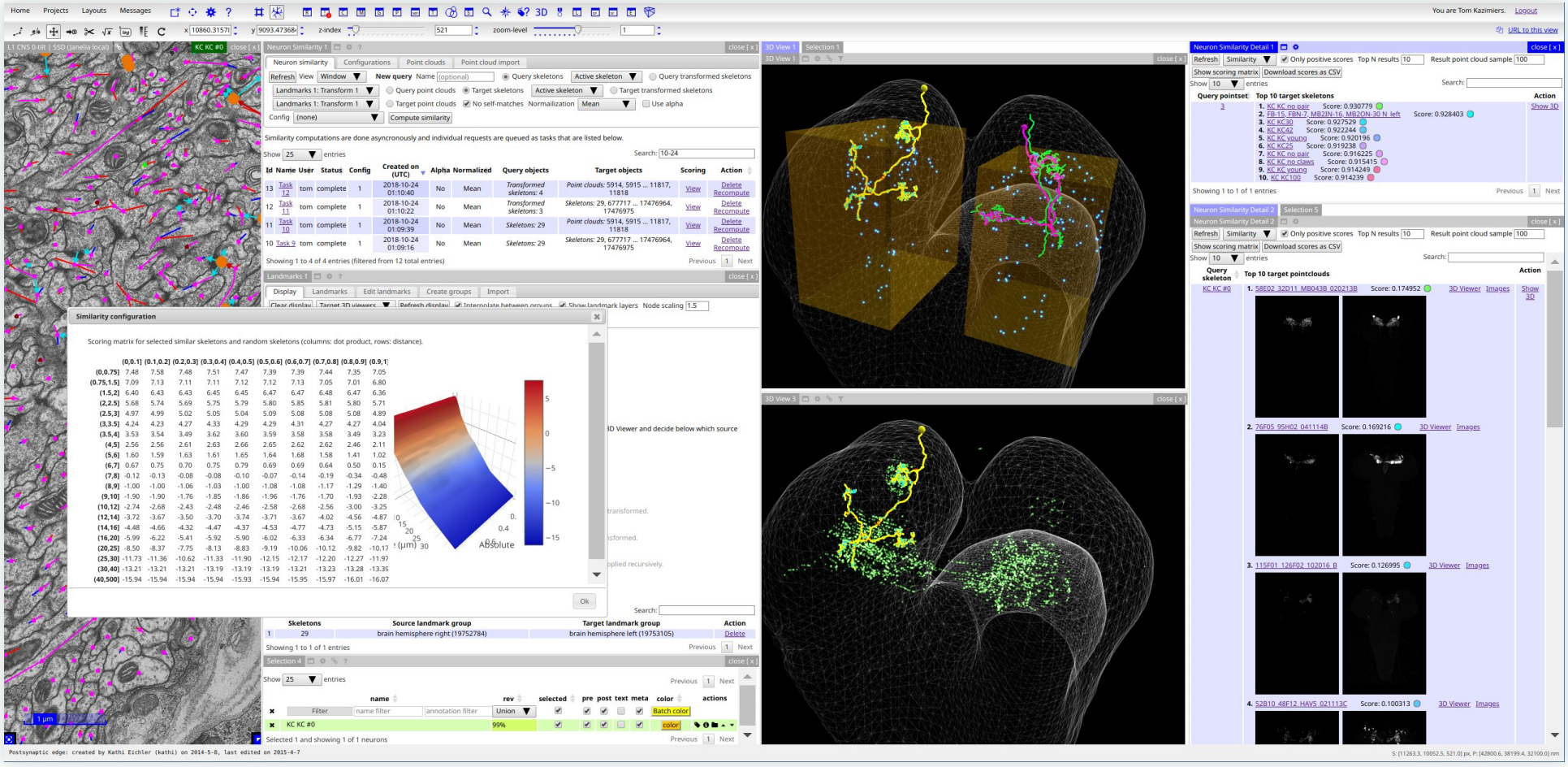
Massive Amounts of Image Data

USER INTERFACE I



Typical CATMAID setup in the FAFBv14 dataset with 2D and 3D views, graphs, synapse fraction display and a partner neuron list. Example circuit from Dolan et al. 2019

USER INTERFACE II



CATMAID in Albert Cardona's L1 dataset with NBLAST scoring matrix configuration and NBLAST results for mirrored query skeleton and LM point clouds.

CATMAID PROJECT ANATOMY

- Projects host user created data
- Image data is mapped into a project
- Image data can have mirrors
- Image data can be collected in stack groups

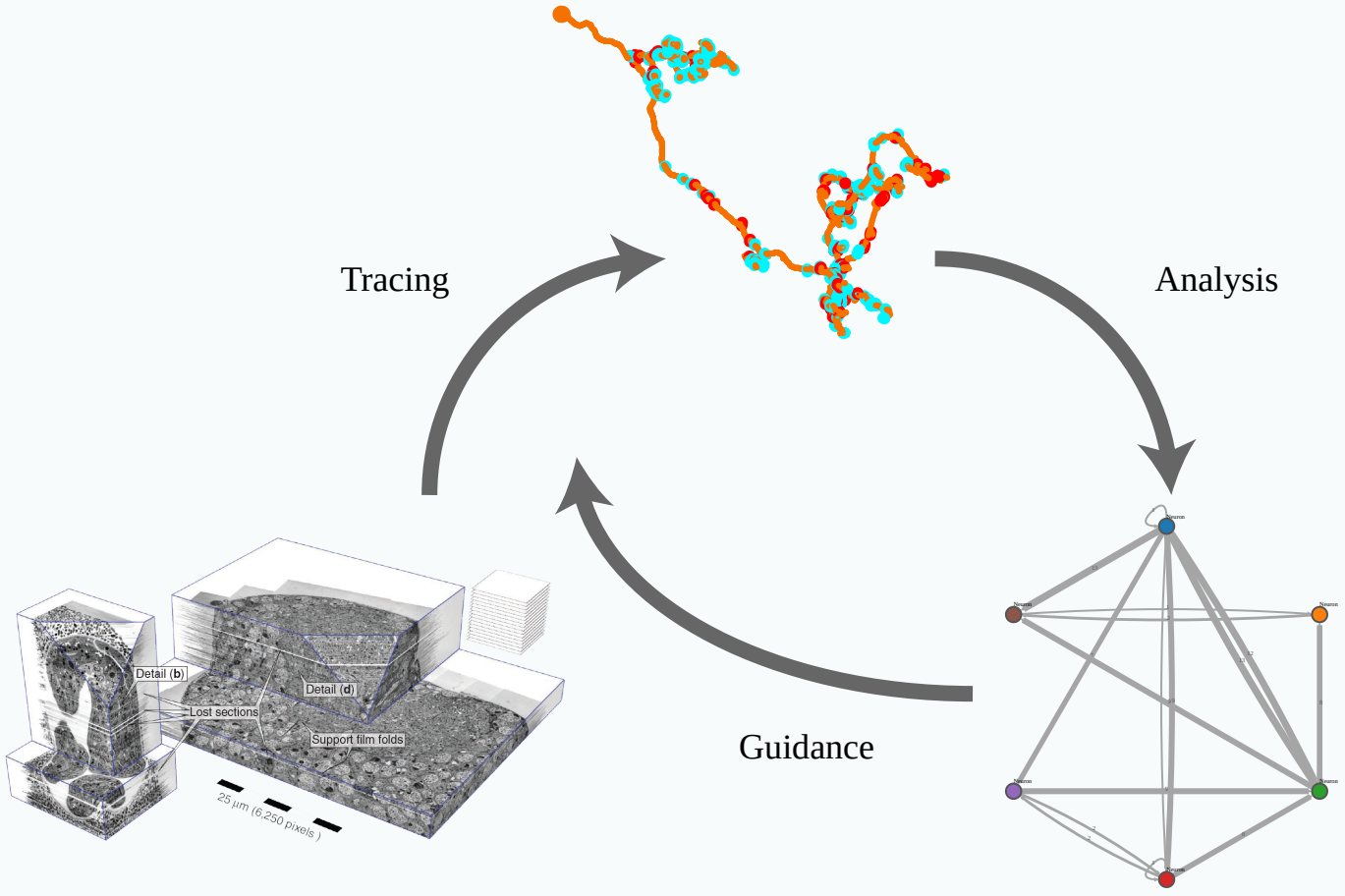
IMAGE DATA

- Currently added by CATMAID admin
- LM and EM, single or multi-channel
- Regular tiles are common
- Increase in *N5* block based rendering
- Orthogonal views

ANNOTATION TYPES

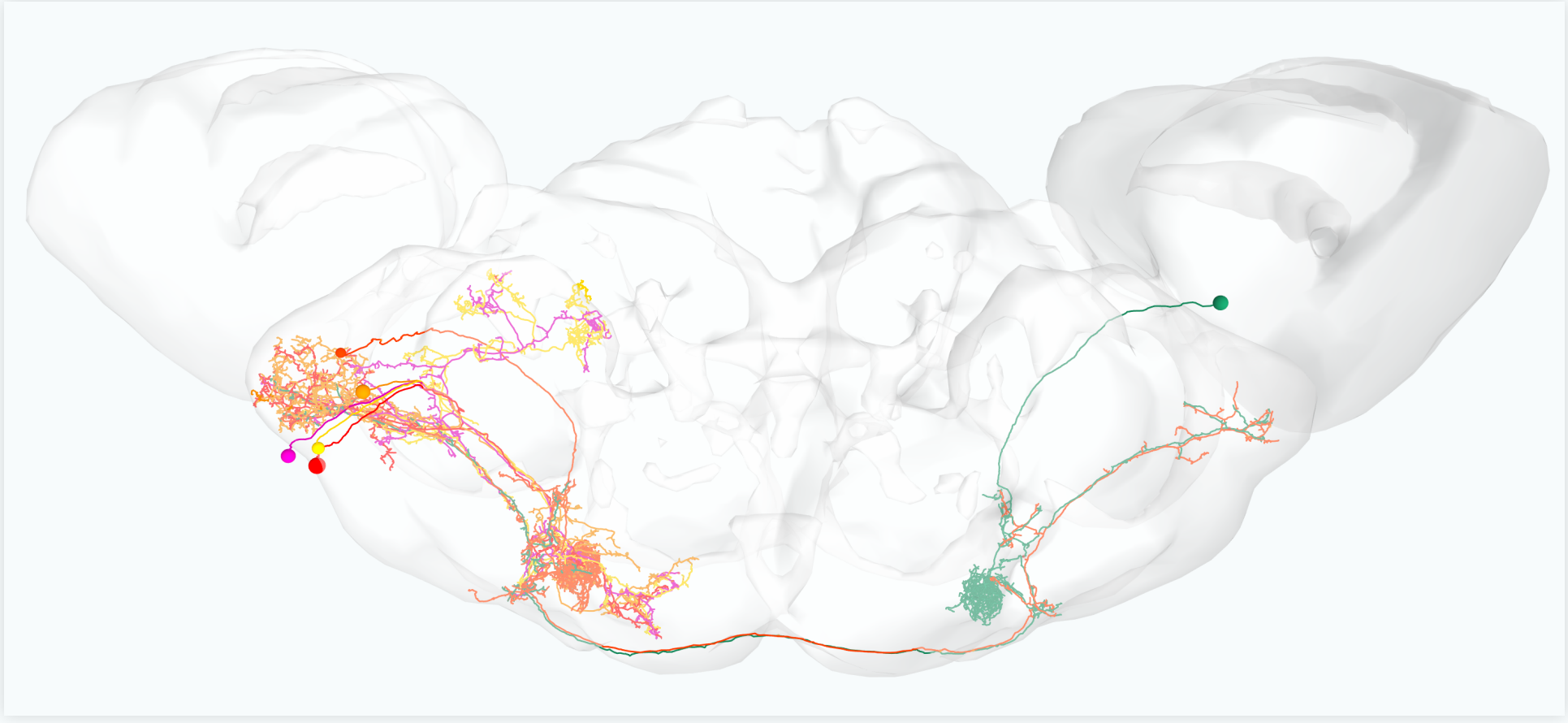
- Simple text and location annotations
- Semantic annotations of the whole image with user definable ontologies
- Skeleton based neuron reconstructions and connectivity

CATMAID



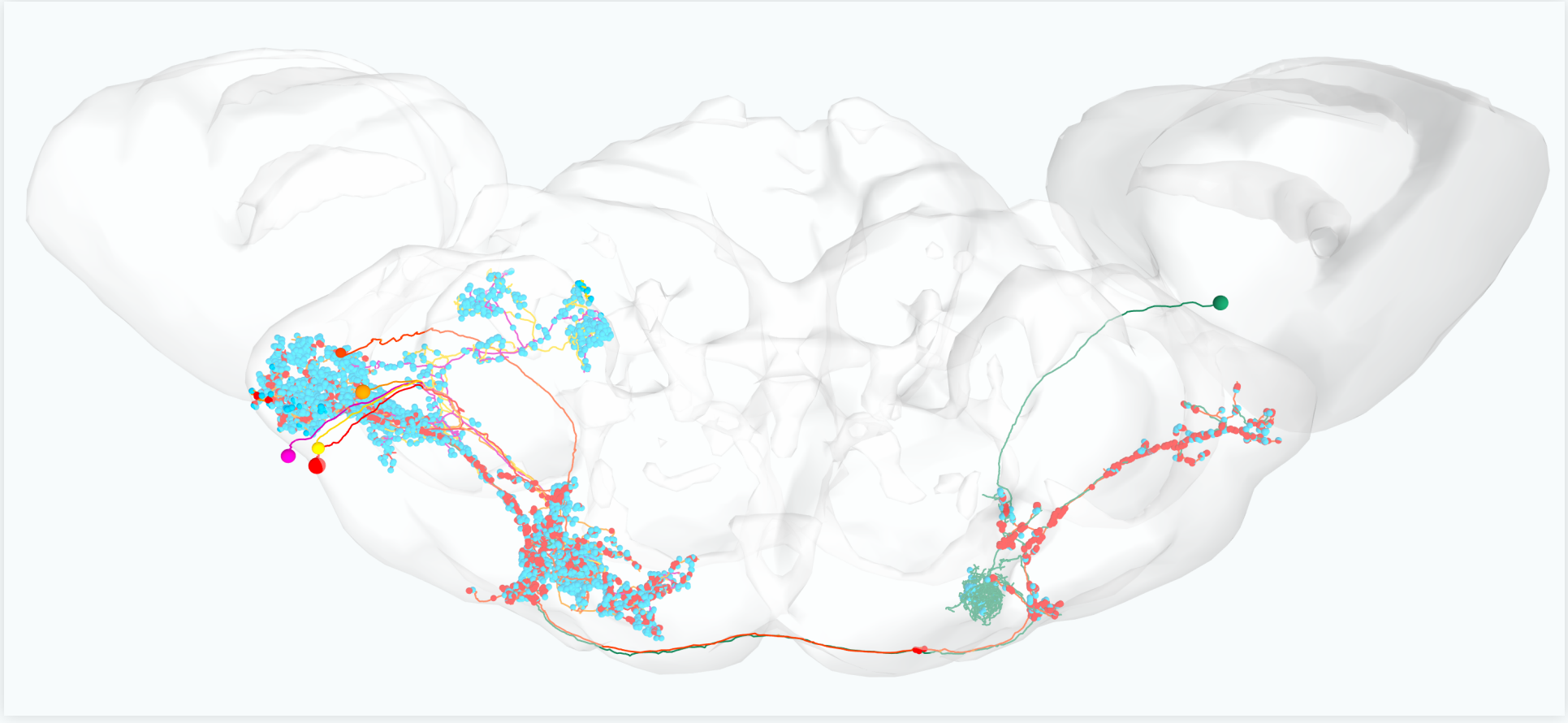
Question directed, Biologically guided, Collaboratively produced

NEURON GRAPHS



First order (downstream) partners (orange/red) to MBON a2sc Left ASB (green), from Dolan and Belliart-Guérin et al. 2018.

NEURON GRAPHS



MBON and PD neurons with synapses highlighted (pre: red, post: cyan), from Dolan and Belliart-Guérin et al. 2018.

NEURON GRAPHS

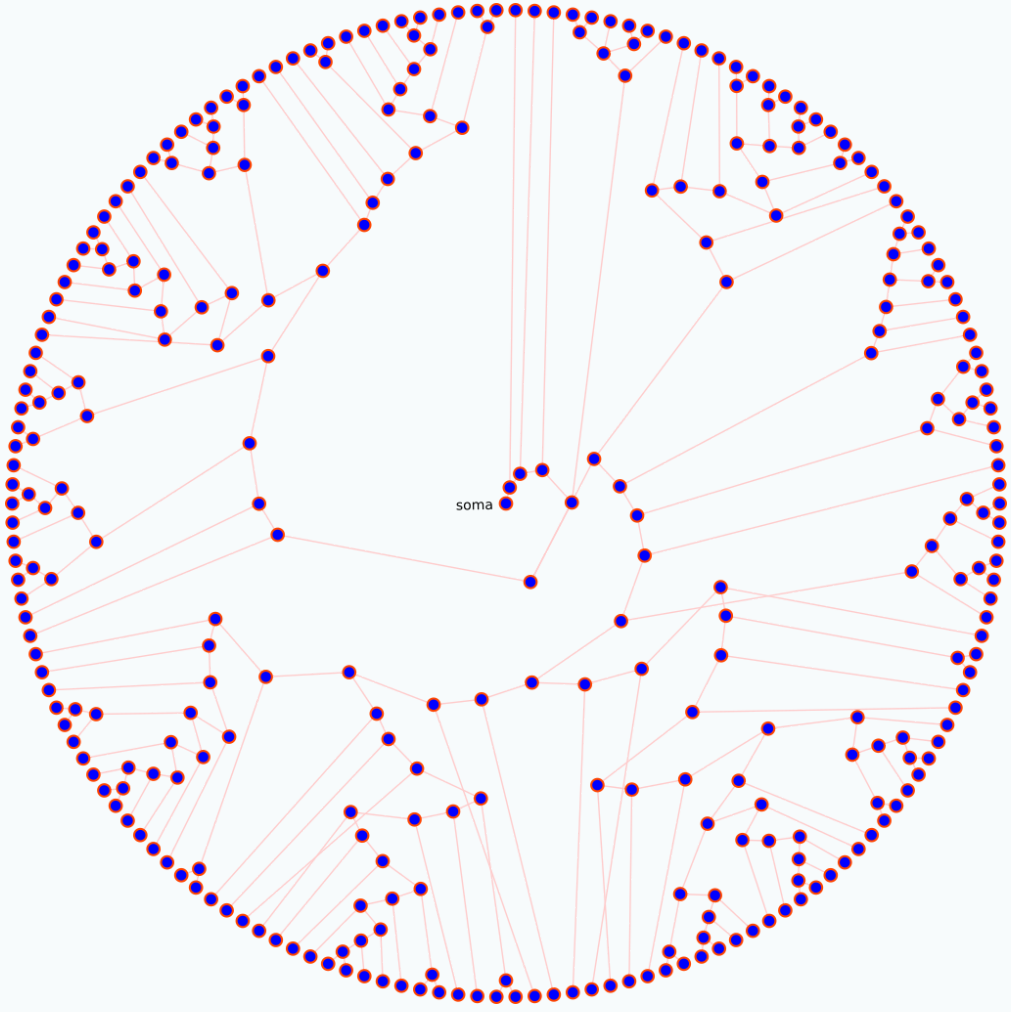
- Connectome is graph between neurons, often times directed, depending on link type
- Neurons consist of linked nodes that form a strict tree structure (skeleton)

NEURON GRAPHS

INDIVIDUAL NEURON

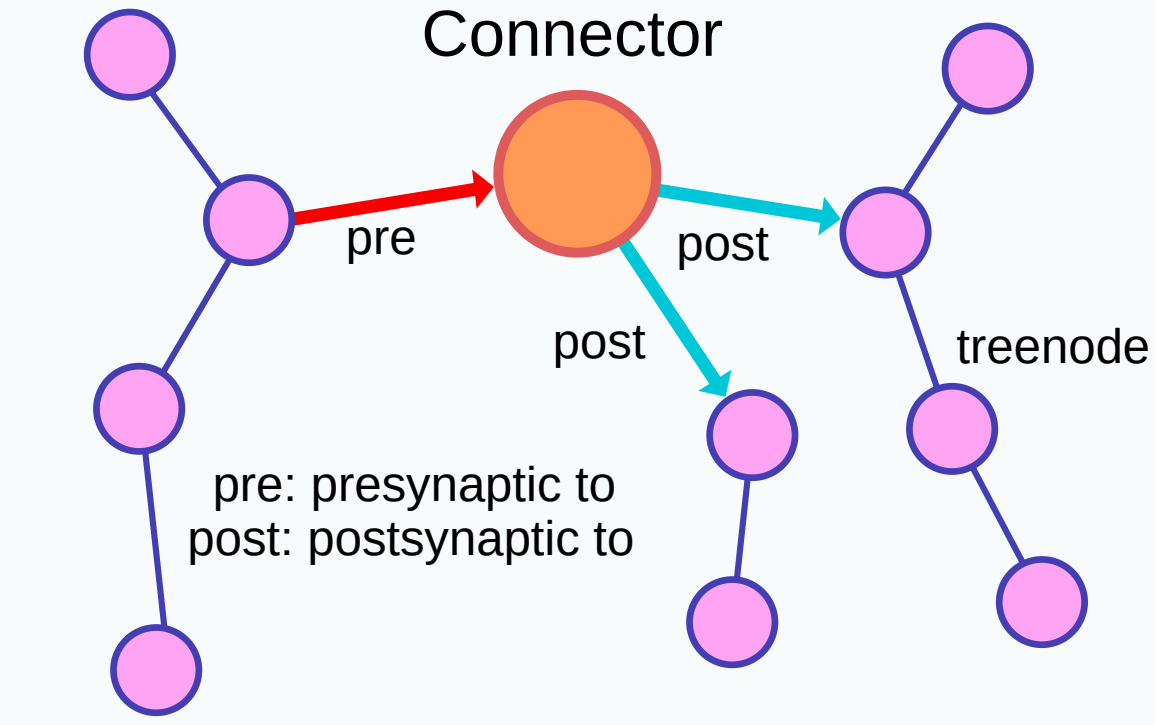
NEURON GRAPHS

INDIVIDUAL NEURON



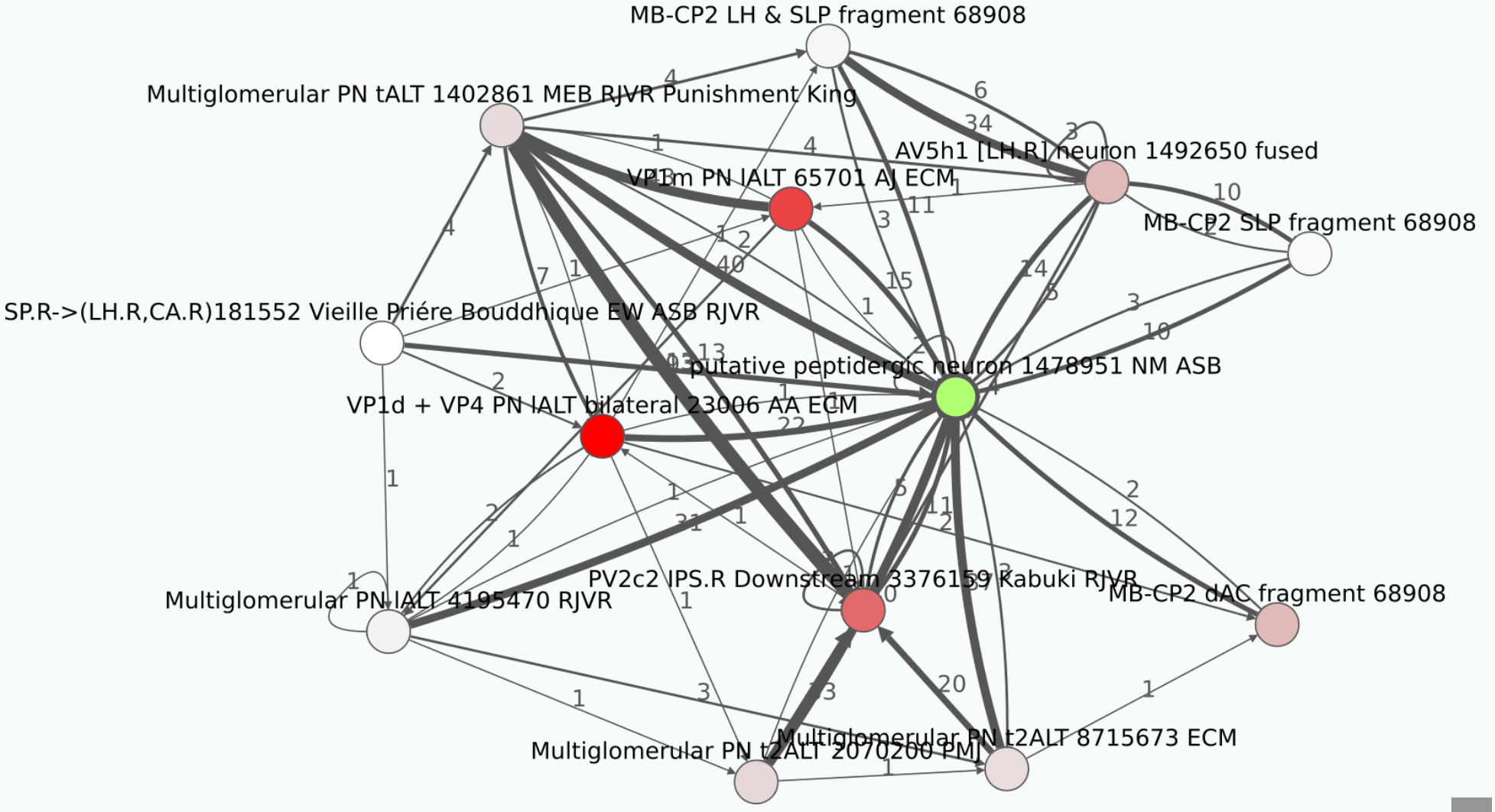
REPRESENTING NEURON GRAPHS

IN CATMAID

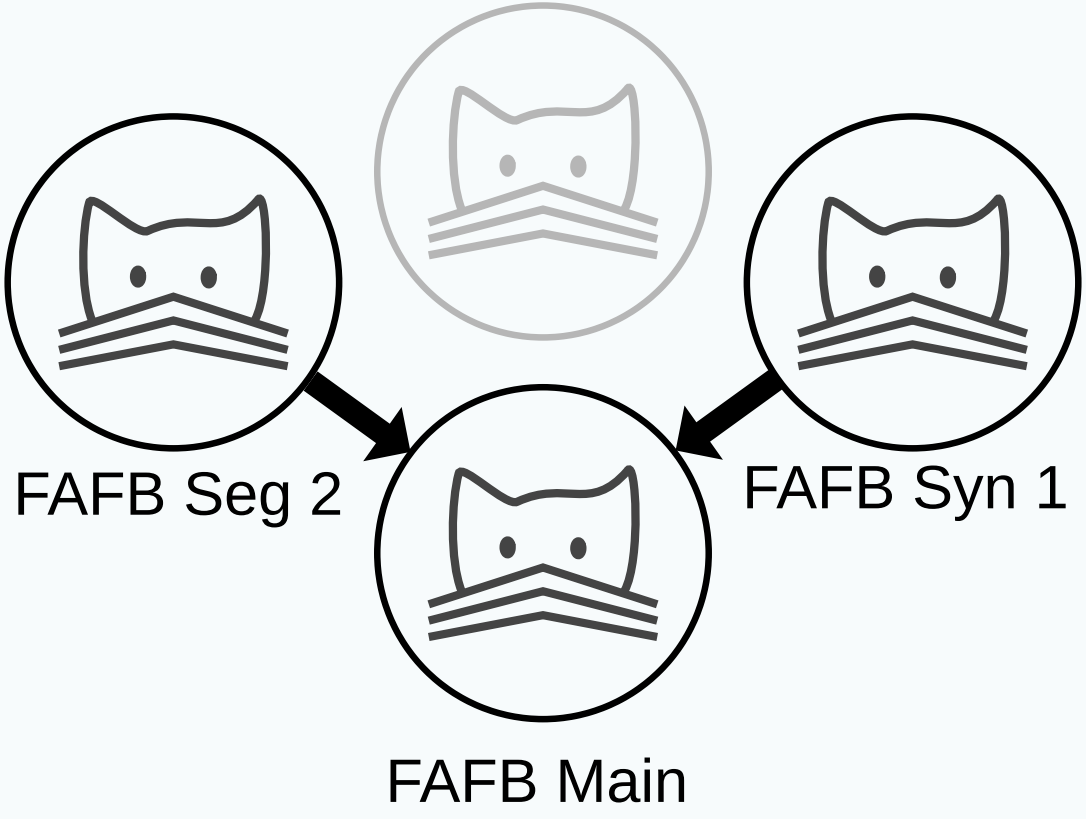


NEURON GRAPHS

CONNECTED NEURONS



FEDERATED DATA



All CATMAID instances can be used individually, but users can use data visible to them across instances.

HANDS-ON

Public CATMAID:
https://spaces.itanna.io/catmaid/itanna/

OTHER COOL FEATURES

- Audit log / history tables
- Undo for many operations
- Many built-in tools
- API access

ACKNOWLEDGMENTS

CONTRIBUTORS

- Albert Cardona
- Andrew Champion
- Chris Barnes
- Stephan Gerhard
- Davi Bock
- Stephan Saalfeld
- Marta Costa
- Greg Jefferis
- Will Patton
- Philipp Schlegel
- Alex Bates

DATA CREATION AND DATA WRANGLING

- Cardona Lab Tracers
- Wellcome Trust Tracers
- CAT Team @ JRC
- Eric Perlman
- Stephan Gerhard

LABS AND TEAMS

- Cardona Lab @ LMB
- Bock Lab @ UVM
- Lee Lab @ HMS
- Lippincott-Schwartz Lab @ JRC
- Reiser Lab @ JRC
- Funke Lab @ JRC

QUESTIONS?

- catmaid.org
- github.com/catmaid/CATMAID
- tom@kazmos.de
- Docker image:

```
docker run -p 8080:80 catmaid/catmaid
```

- The CATMAID project is looking for Google Summer of Code students!
- The Cardona Lab is looking for software engineers!