

Background

- ▶ New neuroimaging datasets are large (10GB to 100TB+)
- ▶ Object detection is a canonical problem
- ▶ Many techniques exist to aid in scene parsing

Challenge

- ▶ Translating algorithms for neuroscience discovery is multi-faceted and complex
- ▶ Solving these issues often requires re-solving common problems
- ▶ A reusable framework would facilitate scientists doing science

Action

- ▶ We developed a flexible analytics toolbox to enable rapid discovery
- ▶ These tools are built into the NeuroData framework
- ▶ Algorithms include a variety of community-developed and custom tools for common workflows

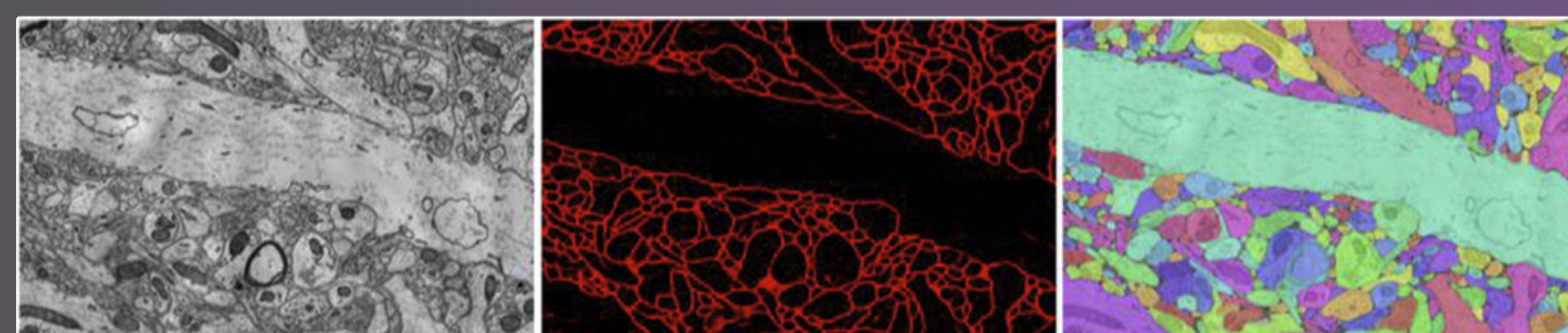
Resolution

- ▶ Our code was used for object detection tasks across multiple modalities, including Array Tomography, X-Ray Microscopy and Electron Microscopy
- ▶ Code, data, and an analytics stack are available at neurodata.io

Background

NeuroData provides an ecosystem of tools and services to enable data sharing and computation:

- ▶ High-throughput reads/writes to spatial database to support high performance computing (HPC)
- ▶ Spatially co-registered image and annotation data
- ▶ Flexible, interoperable RAMON data standard to enable both annotations and metadata
- ▶ RESTful endpoints, with MATLAB and Python interfaces for rapid workflow construction



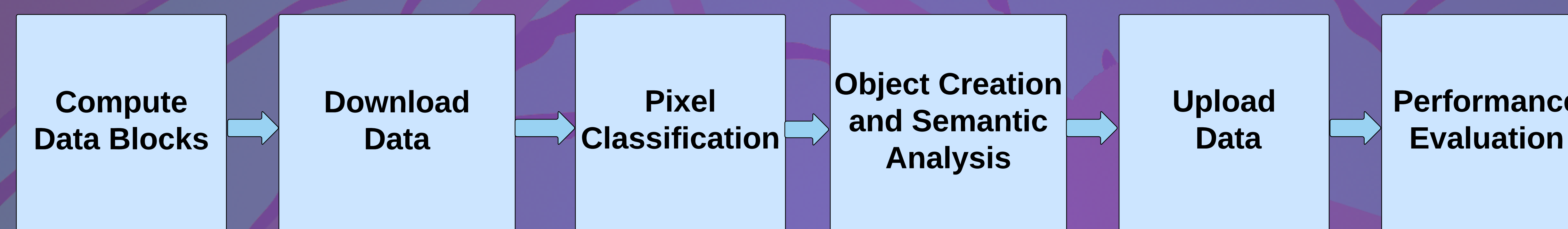
Challenge

Processing neuroscience data at scale requires addressing a wide range of challenges, including:

- ▶ Data storage
- ▶ Data access
- ▶ Algorithm Implementation
- ▶ Algorithm scaling
- ▶ Utilizing computational resources
- ▶ Enabling reproducible science
- ▶ Multiscale scene understanding
- ▶ Recording object metadata
- ▶ Performance Assessment

Action

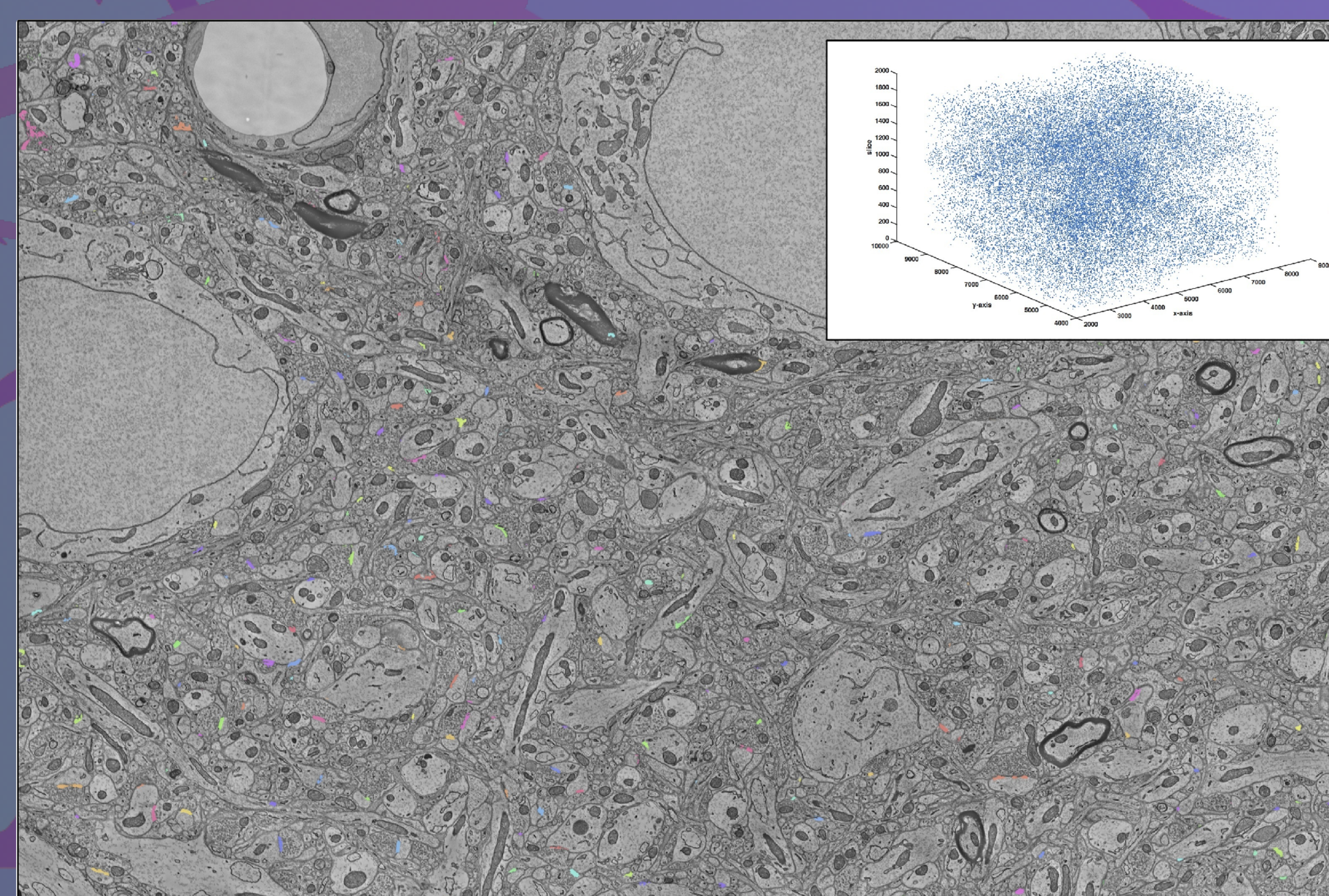
Prototype Object Detection Workflow



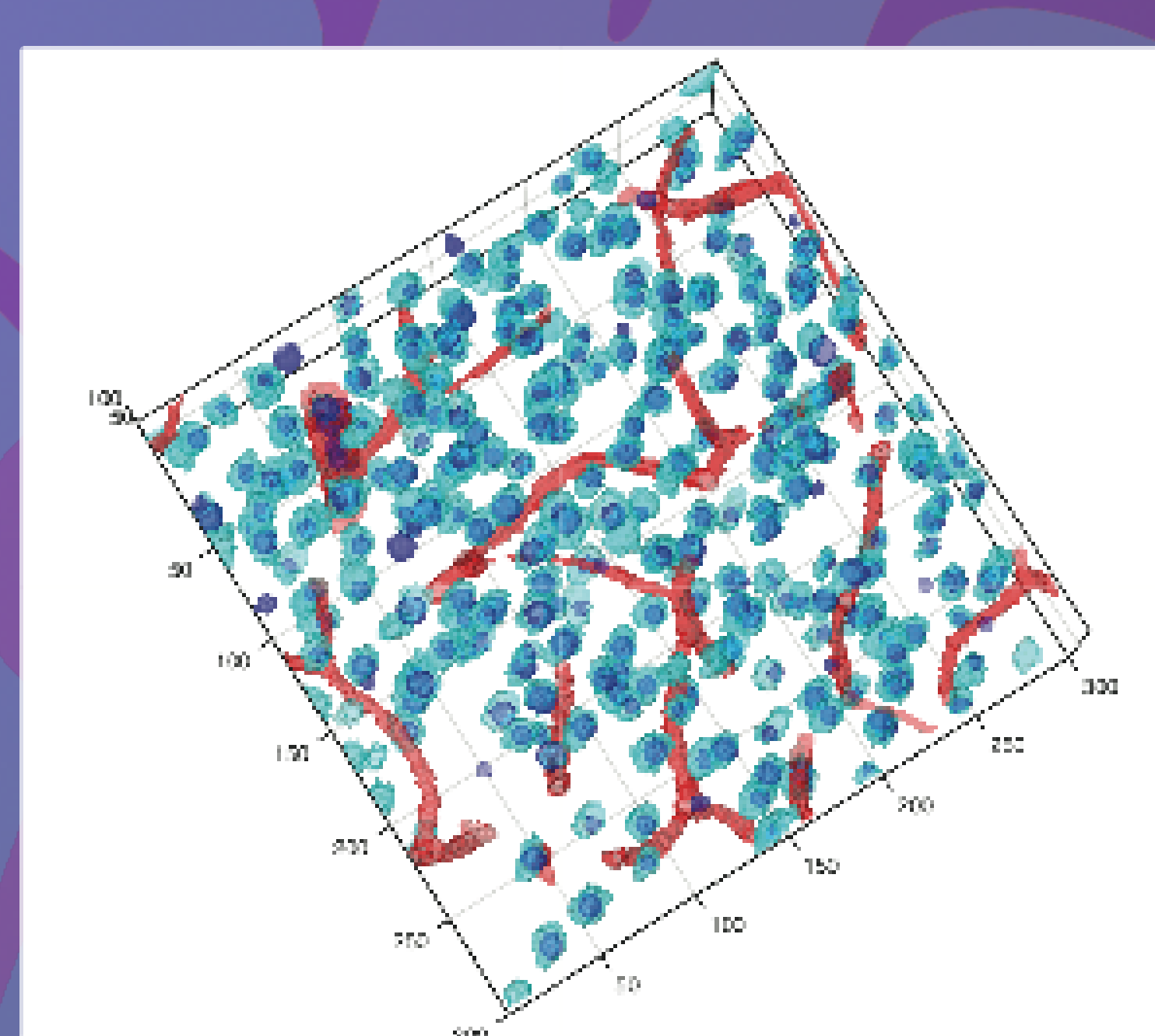
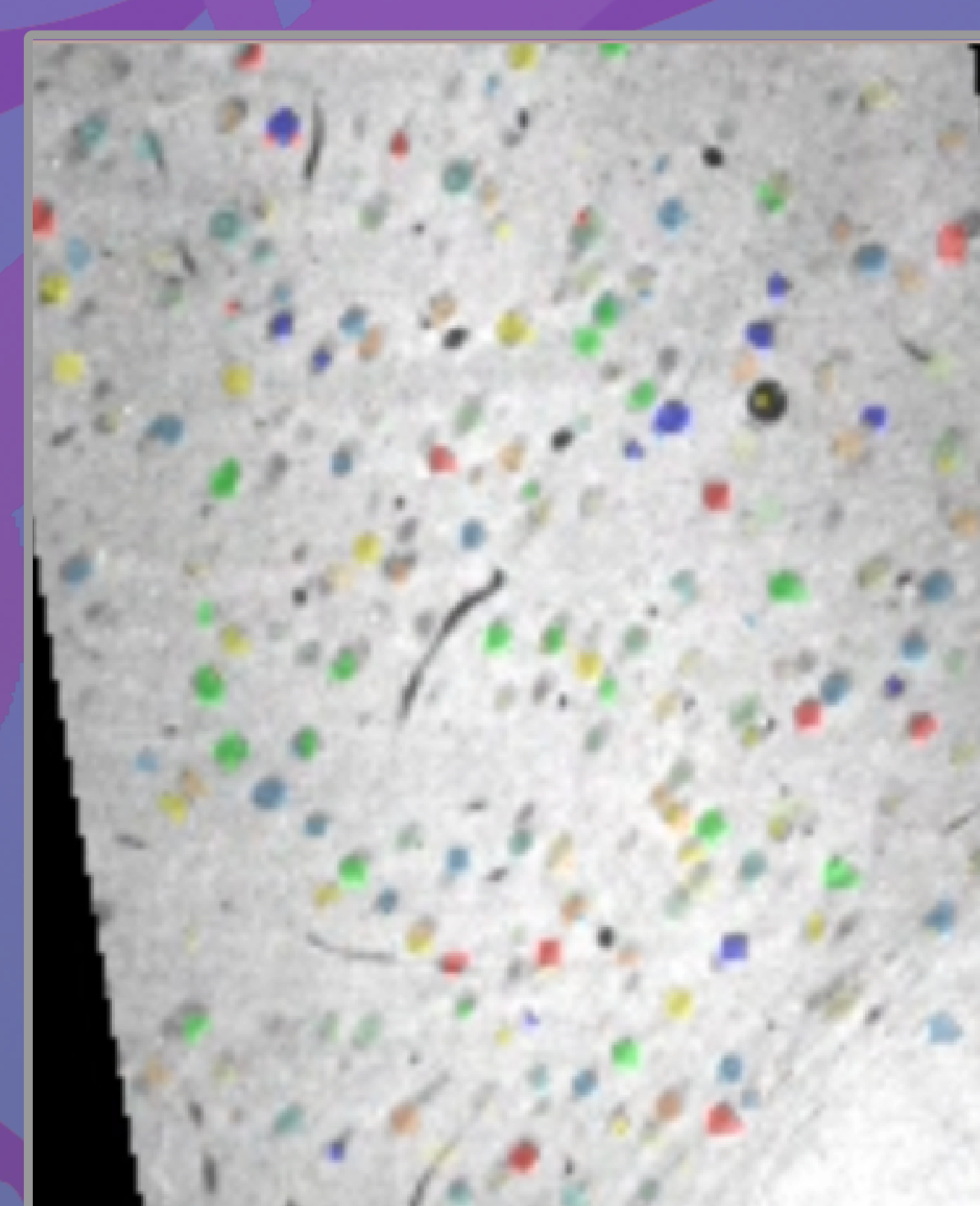
Reusable for any NeuroData dataset

Use integrated community tools - or bring your own algorithm!

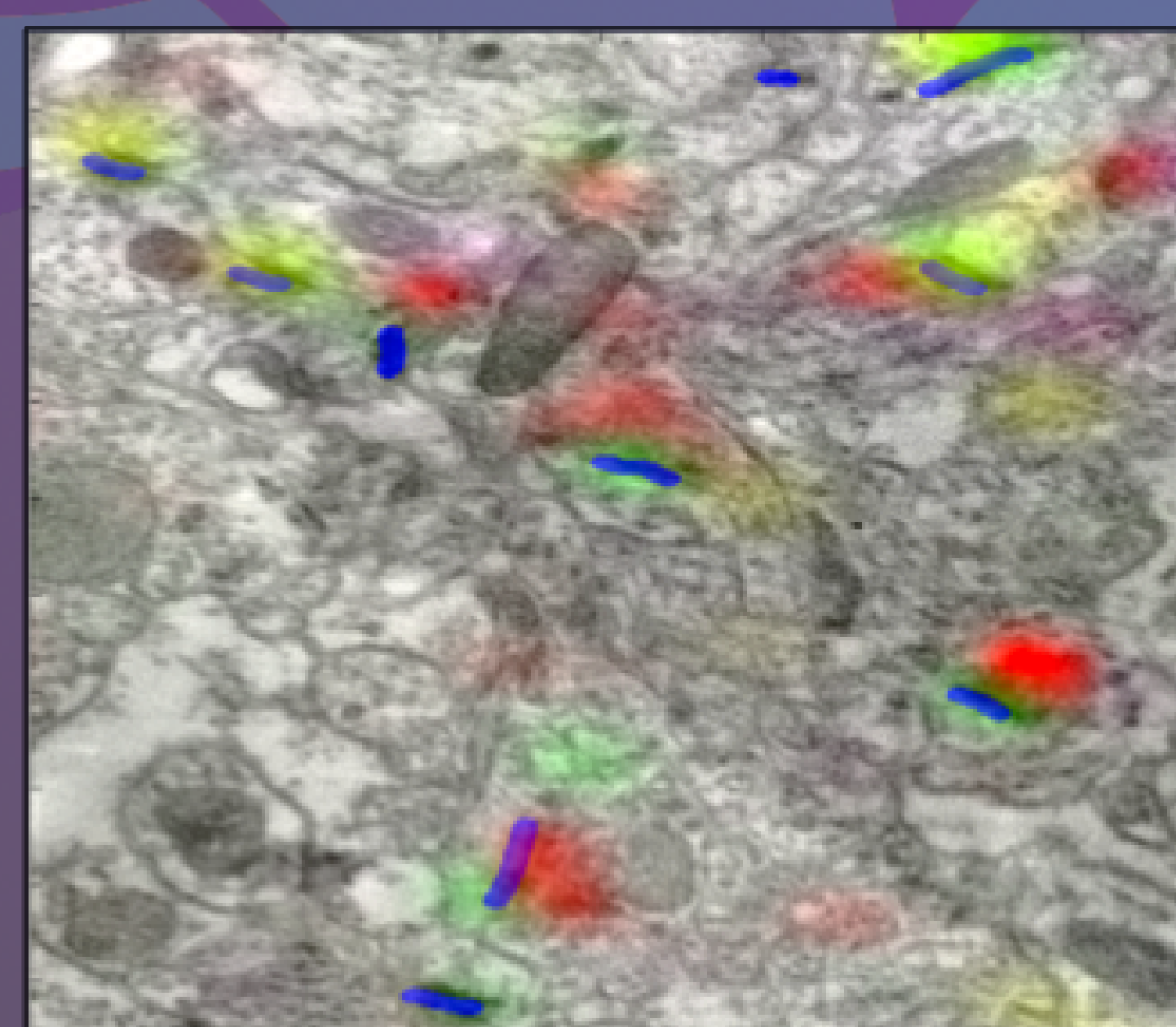
Reusable for any NeuroData dataset



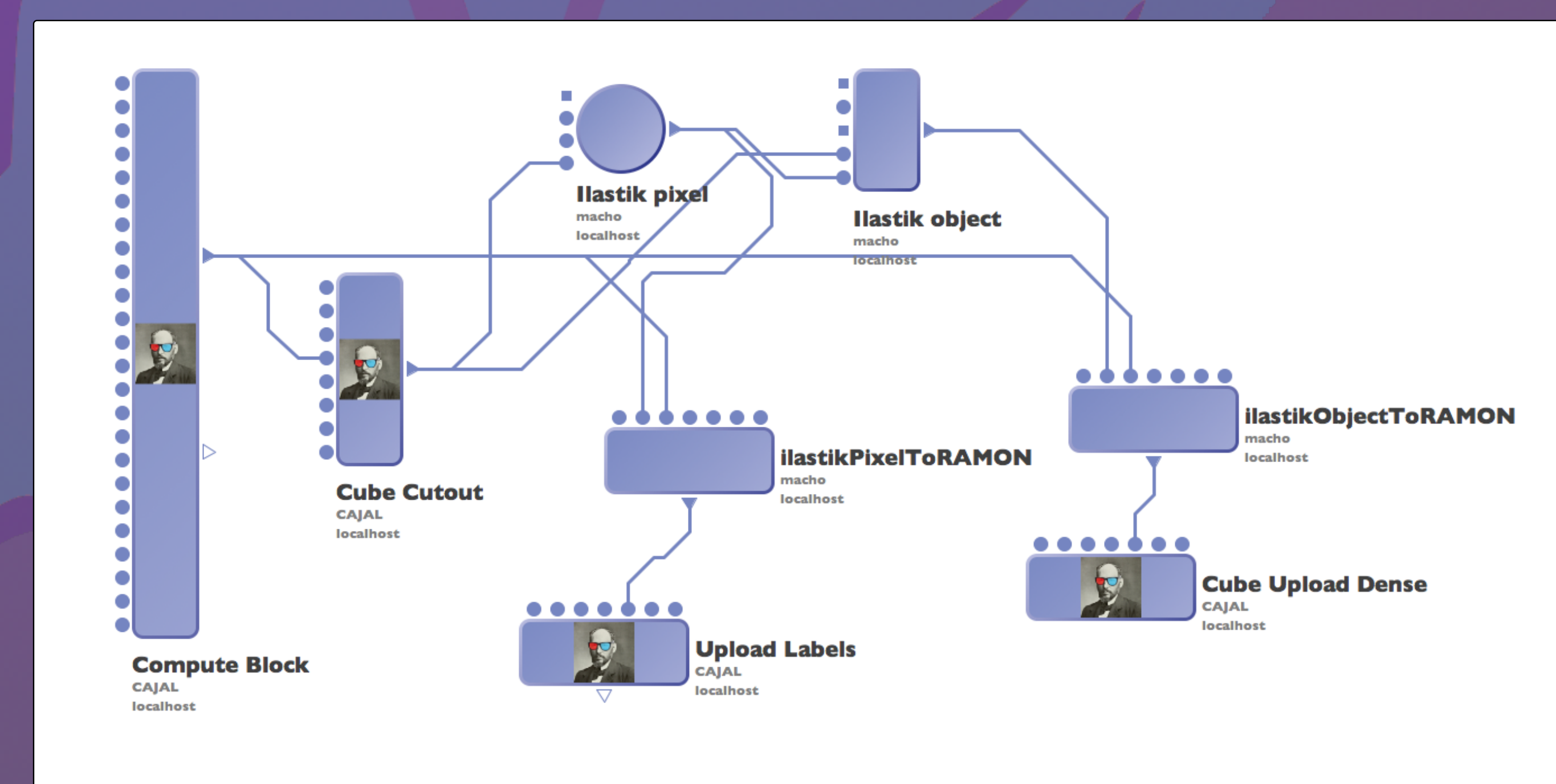
Visualization of large scale synapse detection results; we found a total of 50,000 putative synapses in our volume. An XY slice showing detected synapses is shown, and a point cloud of the synapse centroids are also visualized (inset).



X-Ray Microscopy raw cell detections at scale (left). Manually segmented vessels (red) and cell bodies (cyan). Detected cell bodies are shown in blue.



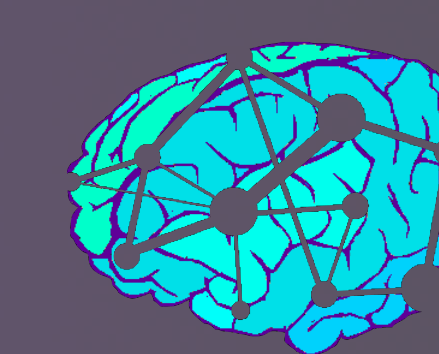
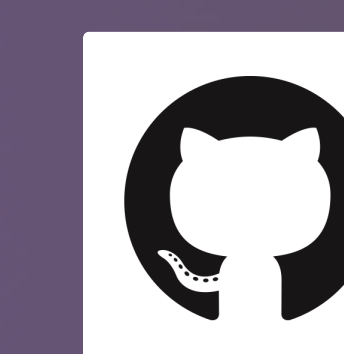
Array Tomography IF Data - EM slice (in grayscale) with IF channels overlaid: PSD-95 (green), synapsin (red), VGluT1 (pink), NR1 (yellow). The synaptic clefts (putative ground truth) are highlighted in blue. A prototype classifier has been developed and tested using the methods described here.



Example LONI workflow, demonstrating the process for object detection using Ilasik, a multipurpose machine learning tool (ilastik.org)

Resolution

- ▶ Code and data are open and available at neurodata.io
- ▶ NeuroDataVision exists as an integrated analytics stack in an Amazon Machine Image for mesoscale processing and prototyping
- ▶ Many algorithms have been included for immediate use; the framework can be easily extended
- ▶ More complex workflows (e.g., graph estimation from images) are also available



References

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