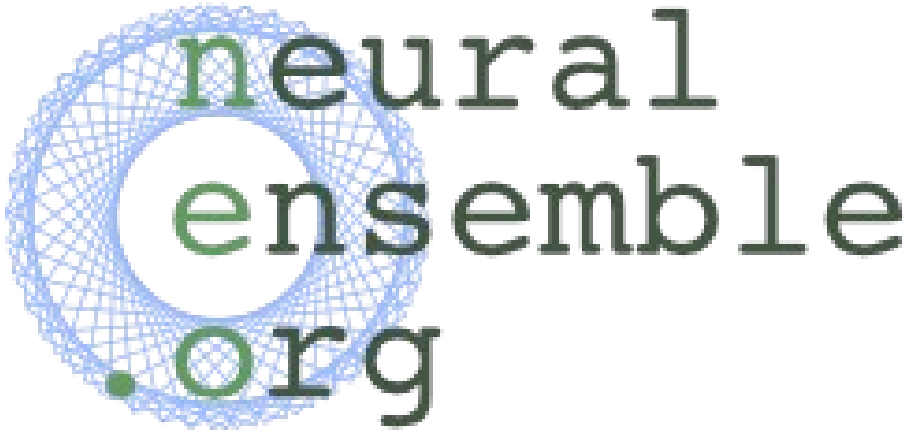
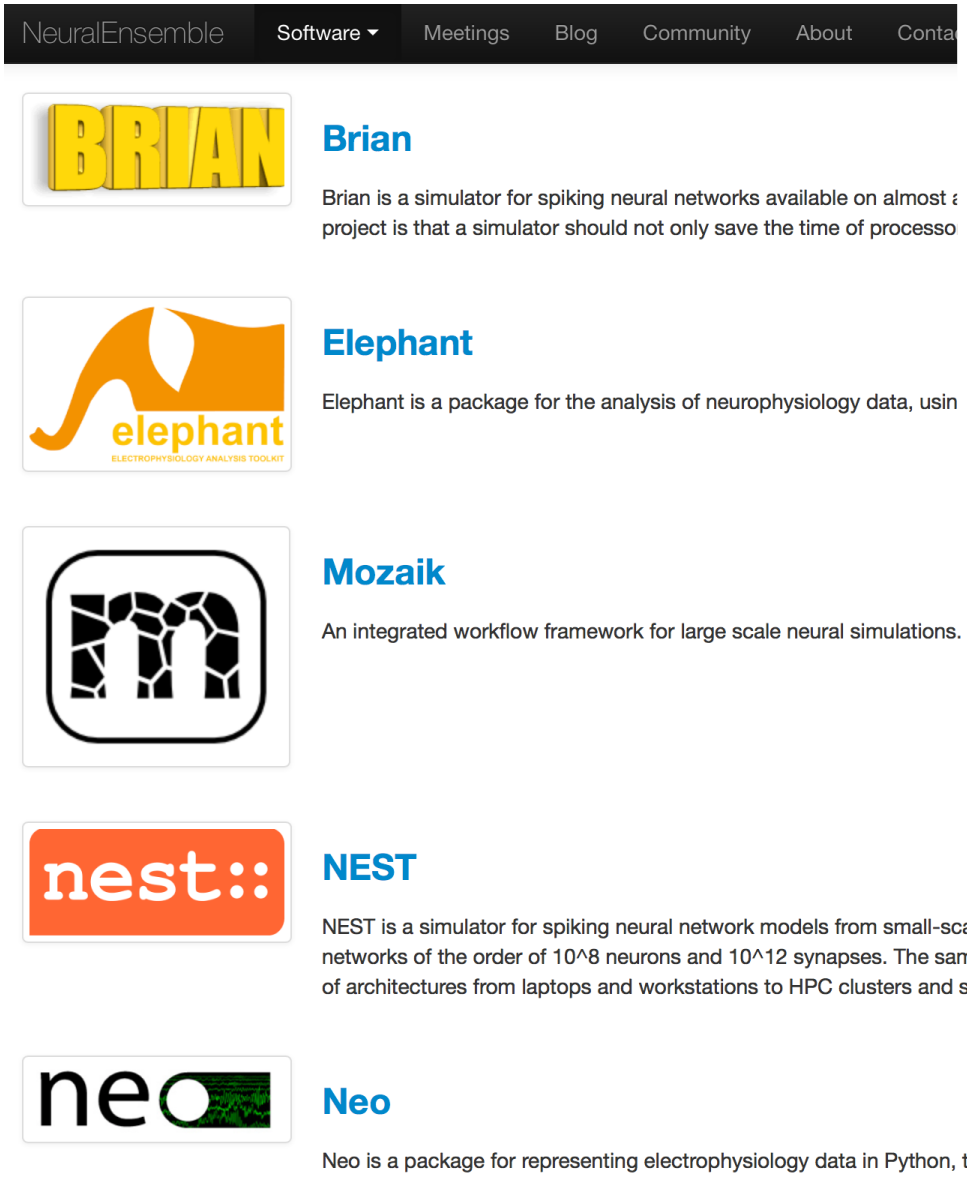


NeuralEnsemble is a community-based initiative to promote and co-ordinate open-source software development in neuroscience.

Software

NeuralEnsemble hosts a number of software projects for computational and systems neuroscience, including PyNN, Neo, Elephant, OpenElectrophy and libNeuroML, mostly hosted on GitHub.

By grouping these projects together under the NeuralEnsemble umbrella, our aim is to maximize interoperability and build components that can easily be combined into powerful systems for brain simulations and advanced data analysis.



Workshops

We organize an annual "CodeJam" workshop, bringing together scientists, graduate students, and scientific programmers to share ideas, present their work, and write code together.

These workshops have been hugely effective in catalyzing open-source neuroscience software development.

Community

There is a NeuralEnsemble Google group for discussion of collaborative neuroscience software development (mainly in Python, but users of other languages are welcome!) and to provide software support.

If you have any questions about any of the software hosted by NeuralEnsemble, please join the group and post a message in one of the forums.

https://groups.google.com/forum/#!forum/neuralensemble

OpenWorm

http://www.openworm.org

OpenWorm aims to build the first comprehensive computational model of the Caenorhabditis elegans (C. elegans), a microscopic roundworm. With only a thousand cells, it solves basic problems such as feeding, mate-finding and predator avoidance. Despite being extremely well studied in biology, this organism still eludes a deep, principled understanding of its biology.

C. elegans background

- Behavior
  - Seeks out food & mates
  - Avoids predators & toxins
  - Has social behaviors
-
- Genomics
  - First fully sequenced organism
-
- Cellular anatomy
  - 302 neurons, 95 muscle cells, ~1000 total cells
  - Every cell division from fertilized egg to adult is known
-
- Connectome
  - Only full organism connectome completed to date.

OpenWorm's goals

Long term

Full scale **simulation** of an organism, **C. elegans**

Medium term

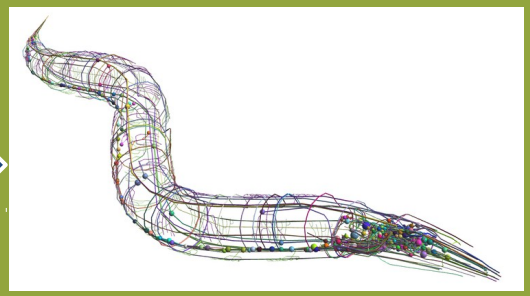
Accurately predict simple **animal behavior** using **a computer model.**

Szigeti et al.
Front. Comp. Neuro., 2014

A complete simulation of the worm's brain, body and environment

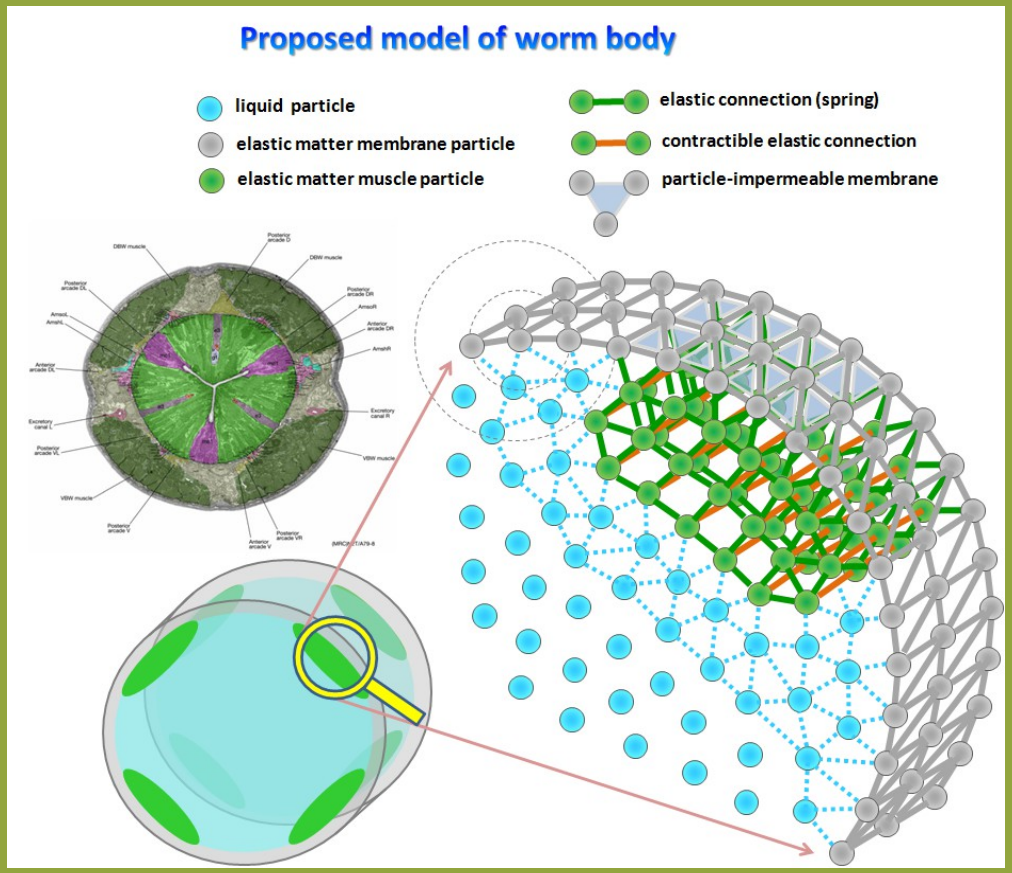
Simulated World

Detailed simulation of worm body

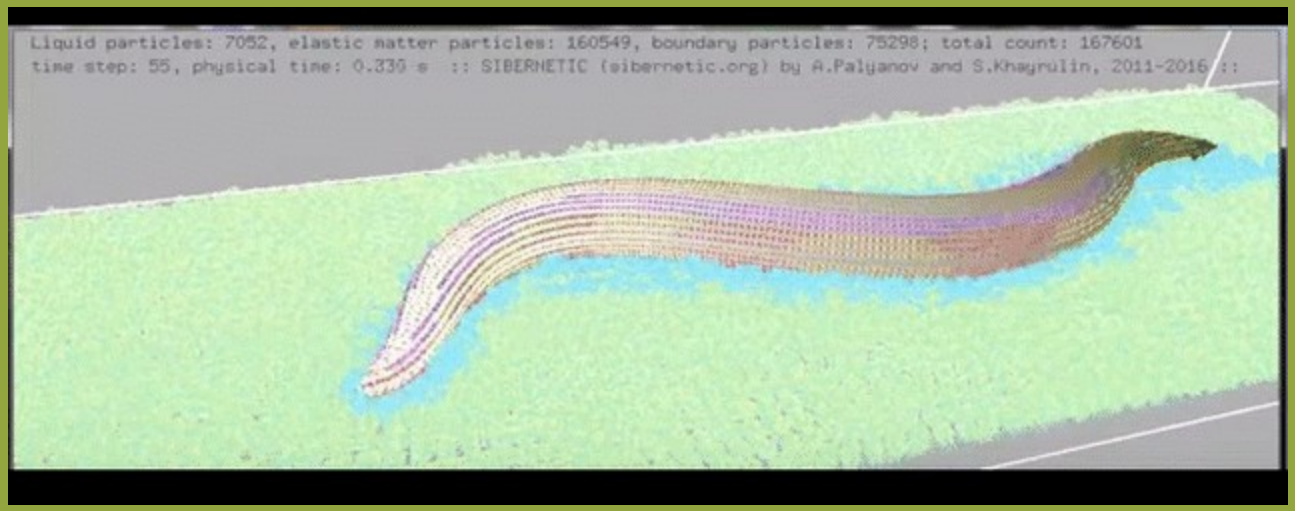


Detailed simulation of worm neurons

OpenWorm



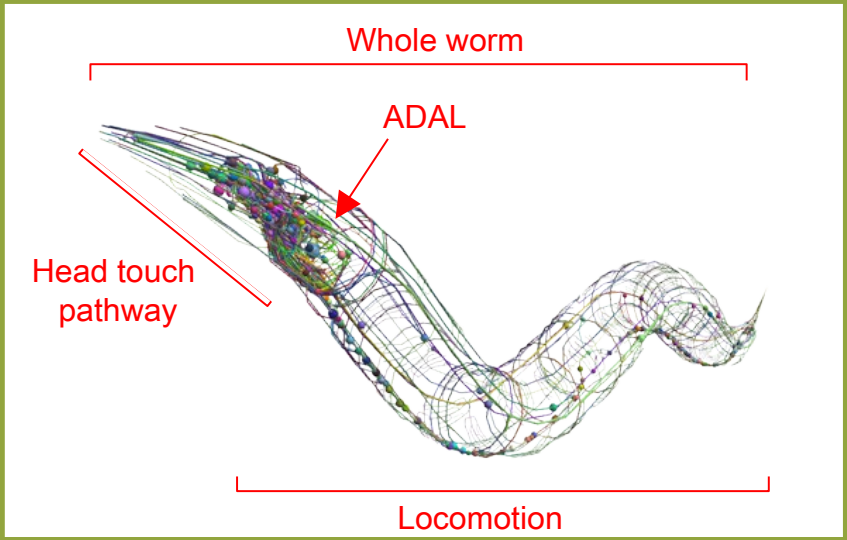
SIBERNETIC

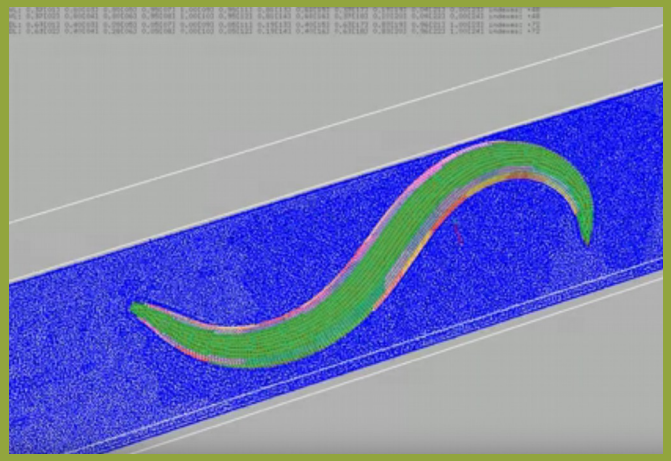


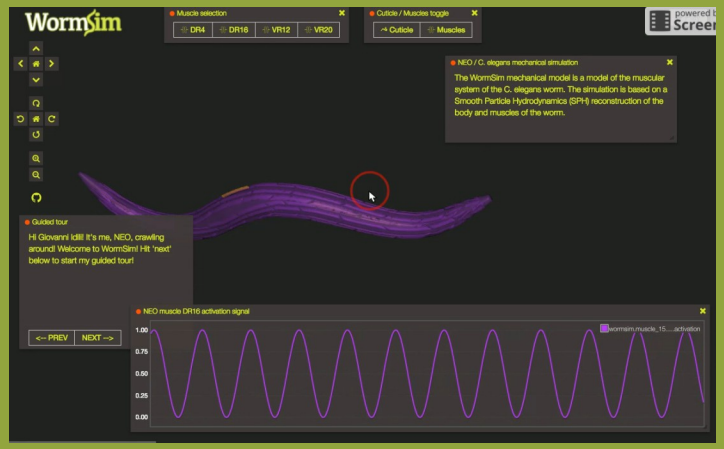
Palyanov, Khayrulin,
(unpublished)

c302

(Subsets of) 302 cell neuronal network in NeuroML







SIBERNETIC

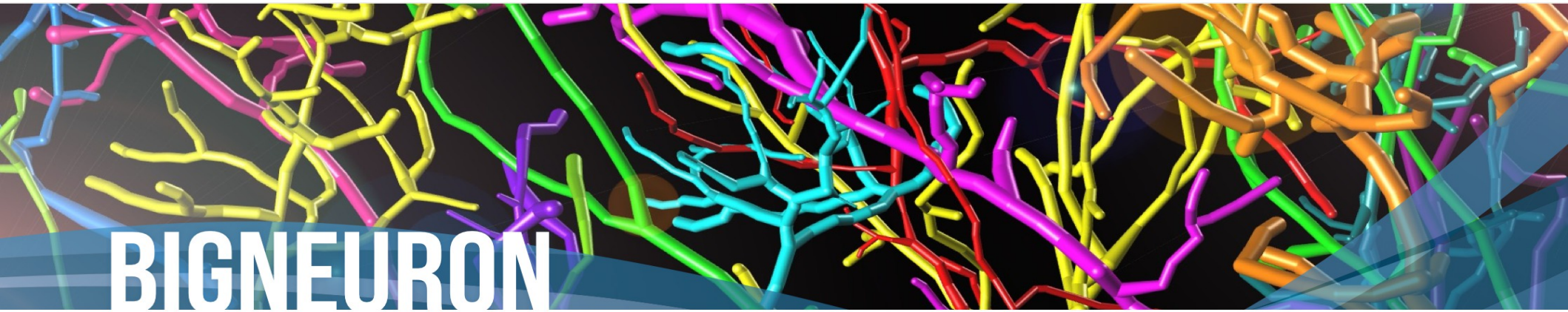
OpenWorm

WormSim

BigNeuron

https://alleninstitute.org/bigneuron

BigNeuron is a community effort to define and advance state-of-the-art of single neuron reconstruction: an essential unsolved challenge in brain science. The project will both standardize the methods to generate high quality and consistent data, and mobilize the reconstruction community to generate interest in solving these complex and interesting algorithmic problems.



BIGNEURON

ABOUT
OVERVIEW
DATA
ALGORITHMS
HACKATHONS & WORKSHOPS
SUPERCOMPUTING
HOW TO PARTICIPATE
FAQ
TERMS & CONDITIONS
CONTACT

GET INVOLVED >

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OVERVIEW

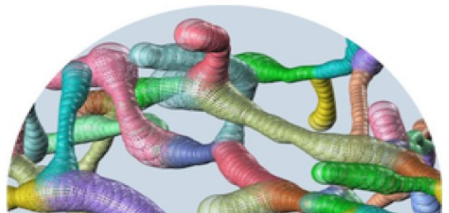
WHY DO WE NEED BIGNEURON?

The three-dimensional shape of a neuron plays a major role in determining its connectivity, integration of synaptic inputs and cellular firing properties, and also changes dynamically with its activity and the state of the organism. Analyzing the three-dimensional shape of neurons in an unbiased way is critical to understanding how neurons function and developing applications to model neural circuitry.

THE PROBLEM

Advances in brain cellular imaging have now yielded thousands of detailed images of neurons from dozens of different organisms stored in personal collections across the globe, comprising many petabytes of data. Dozens of different imaging paradigms and algorithms have now been generated for visualizing the 3D structure of neurons from labs around the world. In order for large data sets to be cross-compared, however, the neuroscience field needs standards – for collecting the data, for determining the acceptable levels of resolution that are most suitable for analysis, and for deciding which analysis approach is the most effective for the most important questions driving the field.

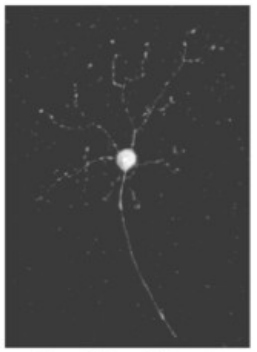
THE SOLUTION

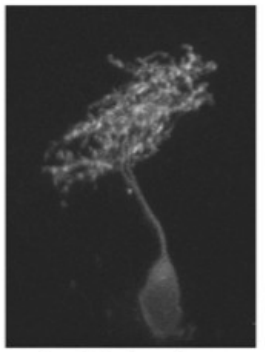


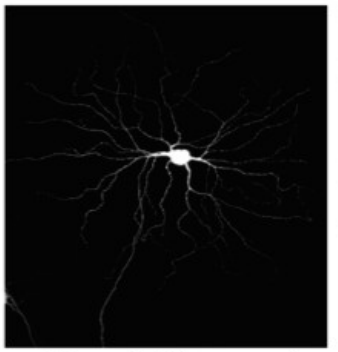
BigNeuron is a community effort to define and advance the state-of-the-art of single neuron reconstruction and analysis, and to create a common platform for analyzing 3D neuronal structures. The major goal of BigNeuron is to bench-test on a common open platform as many open-source, automated neuron reconstruction algorithms as possible with very large scale, publicly available single 3D neuron image data sets acquired by several light

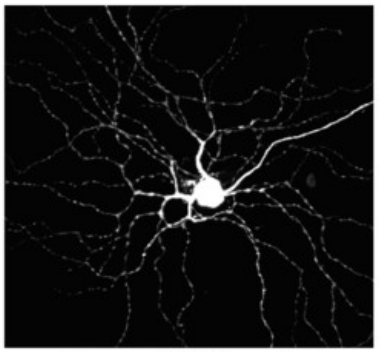
BigNeuron Initiative

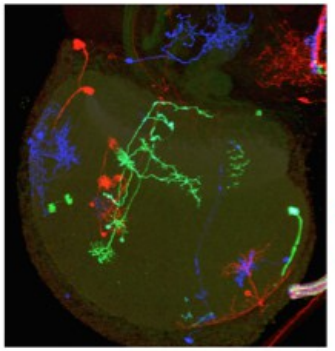
- *A community effort to find out what is exactly the state-of-the-art of single neuron reconstruction, standardize the protocols, and establish a Big Data resource for neuroscience.*
- Phase 1 will be 1~1.5 year establishing the technical platforms (3 week-long algorithm-porting hackathons @Asia/Europe/USA, 1 week-long ground truth annotation workshop @ USA, bench-test on 3 fastest supercomputers in US and Europe based on 20k+ single neuron datasets, Open release and analysis of reconstructions).
- 29+ algorithms ported, 30,000+ neurons collected, 166 gold standard neuron reconstructions produced (6~7 annotators per neuron), ~140 silver standard annotations
- Sample images (see right)

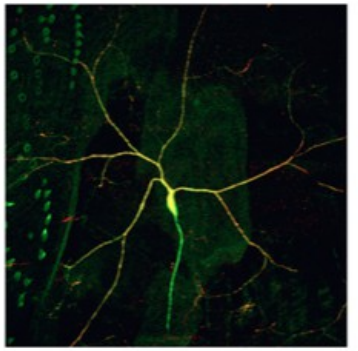

Zebrafish: adult RGC

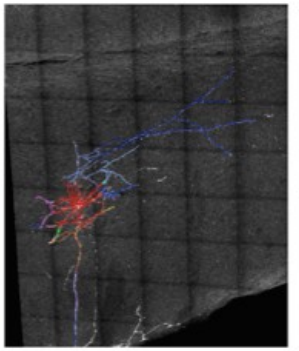

Zebrafish: larval RGC

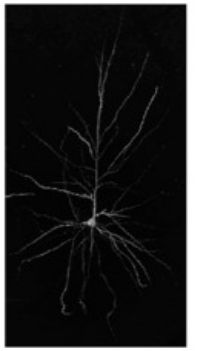

Mouse: RGC (coarse rez)


Mouse: RGC (fine rez)


Fruitfly CNS: optic lobe (unipolar)


Fruitfly PNS: multipolar


Mouse: V1L5


Human

ALLEN INSTITUTE for BRAIN SCIENCE Fueling Discovery

HHMI janelia farm research campus

Human Brain Project

wellcome trust

FlyCircuit A Database of Drosophila Brain Neurons

Krasnow Institute for Advanced Study

OAK RIDGE National Laboratory

BERKELEY LAB Bringing Science Solutions to the World

NeuroMorpho.Org

UNIVERSITY OF CAMBRIDGE

THE UNIVERSITY OF TOKYO

Maebashi Institute of Technology 前橋工科大学

Agency for Science, Technology and Research

THE UNIVERSITY OF GEORGIA

NIU

UNIVERSITY of WASHINGTON

華中科技大學 HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

THE UNIVERSITY OF SYDNEY

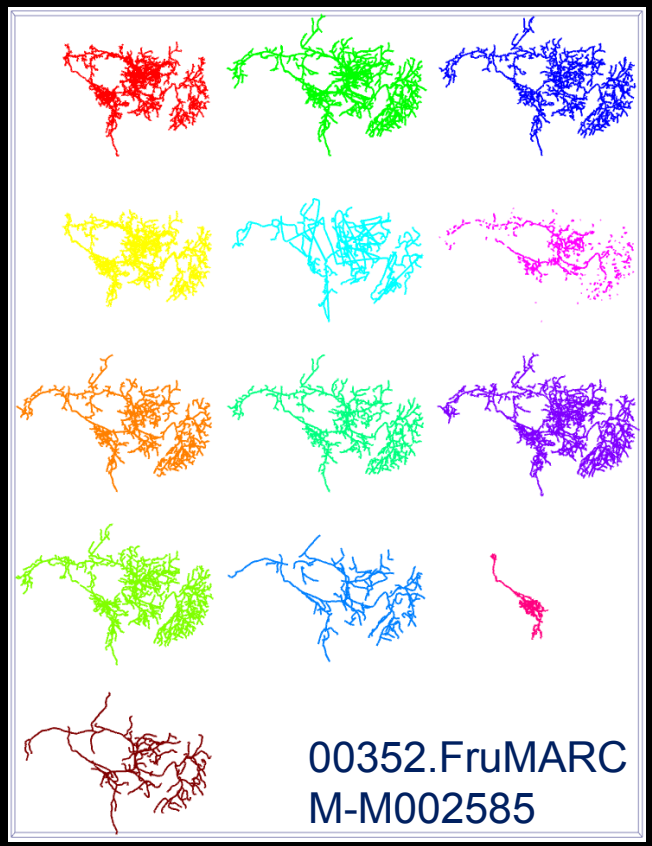
KIST Korea Institute of Science and Technology

Erasmus MC

~50 Ported Neuron Tracing Algorithms and Implementations

- https://docs.google.com/spreadsheets/d/1eU0QYomvs4SQVfFbnnnIdAYh0g-u_2ozqG6rFzW3isQ/edit#gid=1009169397
- Algorithms developed from different perspectives
- Other neuron preprocessing, utility, search, post-processing, visualization methods also ported

Snapshot of bench testing results

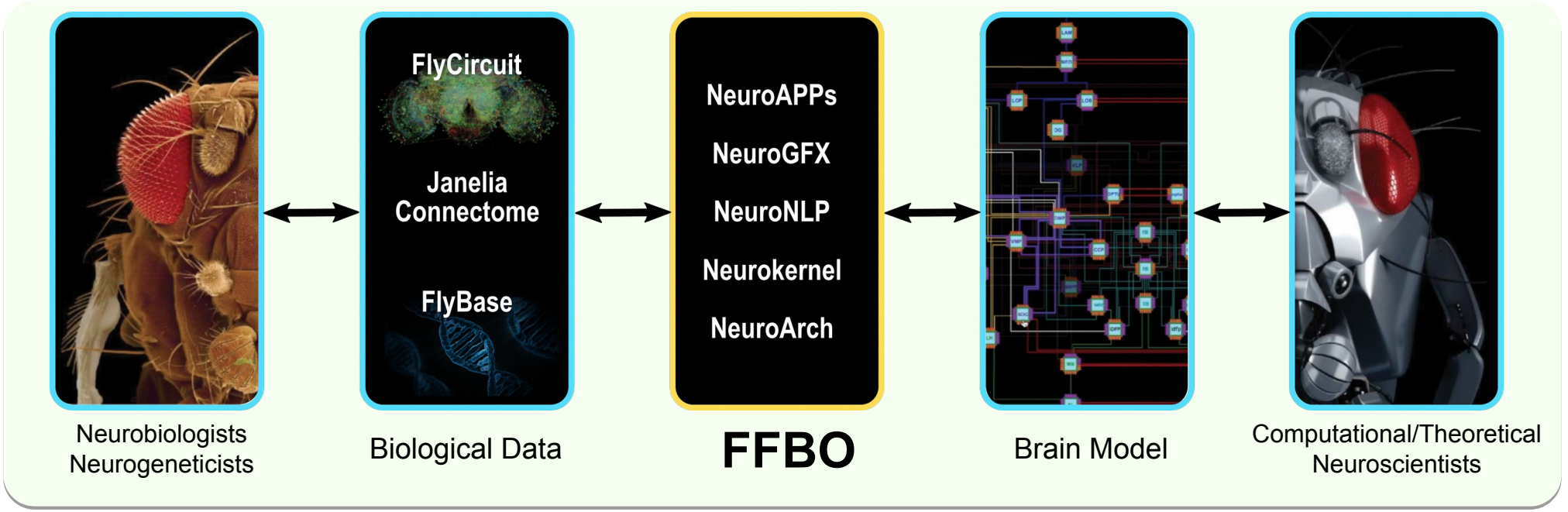


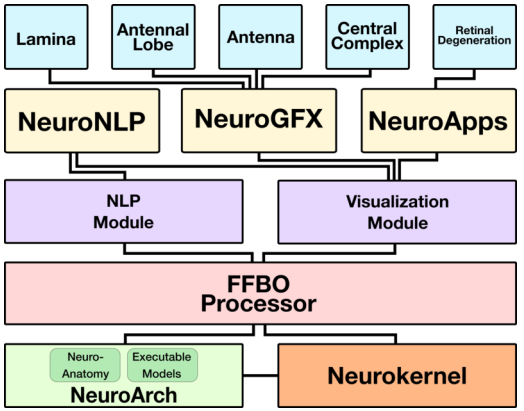
Fruit Fly Brain Observatory

http://fruitflybrain.org
https://github.com/fruitflybrain

An open-source collaborative research platform that integrates biological data with computational models, and serves as a meeting ground for researchers to study fruit fly brain function in health and disease.

The **Fruit Fly Brain Observatory (FFBO)** aims to provide a meeting ground for researchers, including neurogeneticists/neurobiologists and theoretical/computational neuroscientists.





Architecture of FFBO

The FFBO presents two key applications to address, respectively, the following challenges:

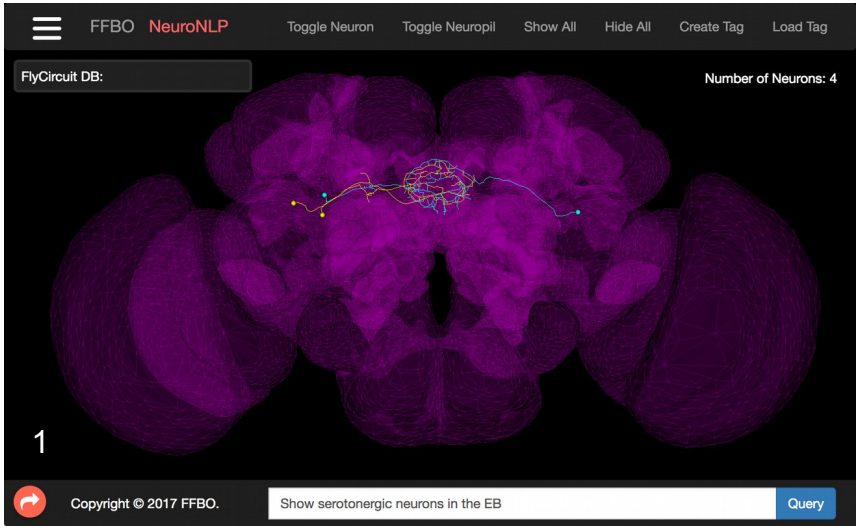
- NeuroNLP: seamlessly integrate structural and genetic data from multiple sources that can be intuitively queried, effectively visualized and extensively manipulated.
- NeuroGFX: devise executable brain circuit models anchored in structural data for understanding and developing novel hypotheses about brain function.

Try NeuroNLP on your smartphone!

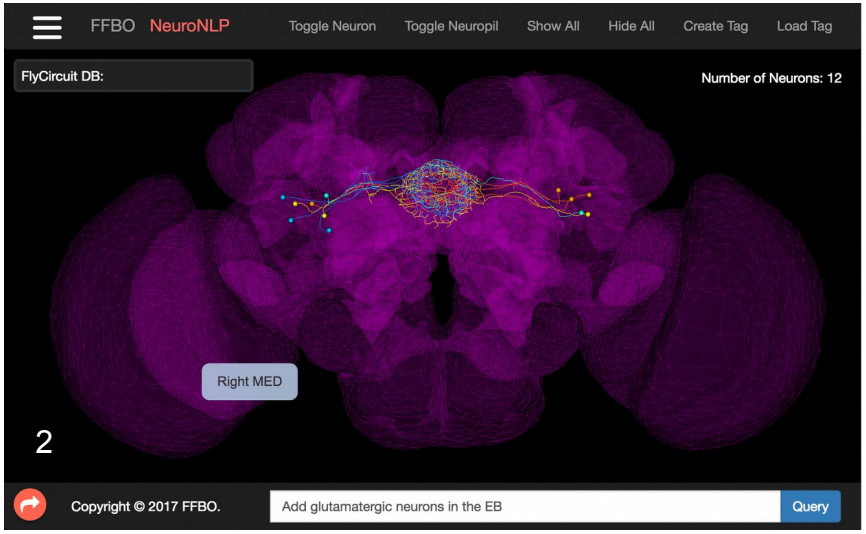
NeuroNLP: A Portal for Aggregated Fly Brain Data

https://neuronlp.fruitflybrain.org

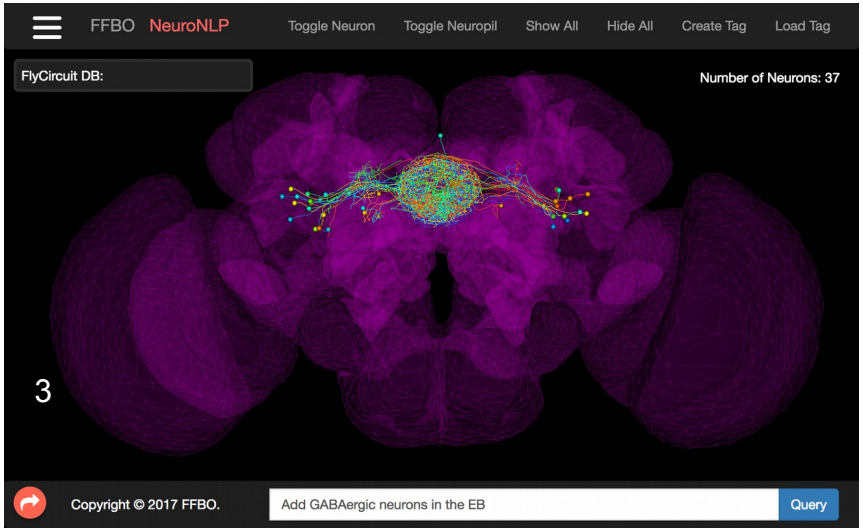
A modern web-based portal for navigating fruit fly brain circuit data using **natural language queries**



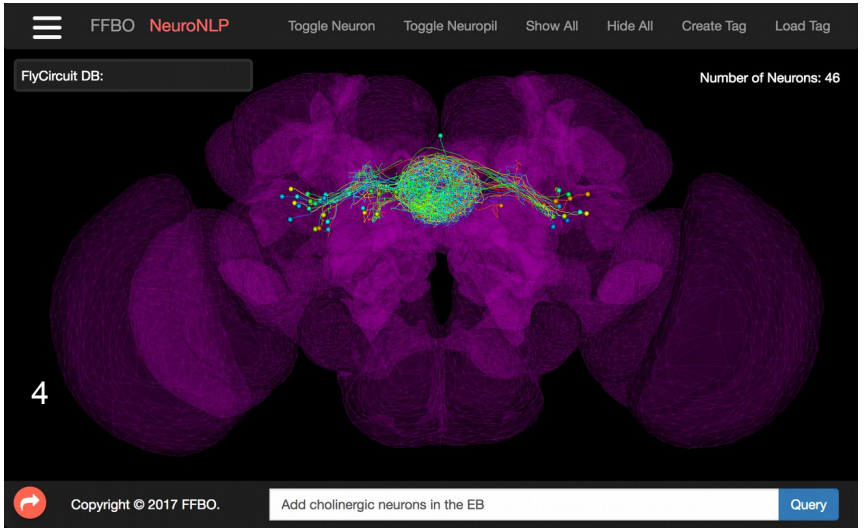
Show serotonergic neurons in the EB



Add glutamatergic neurons in the EB



Add GABAergic neurons in the EB



Add cholinergic neurons in the EB

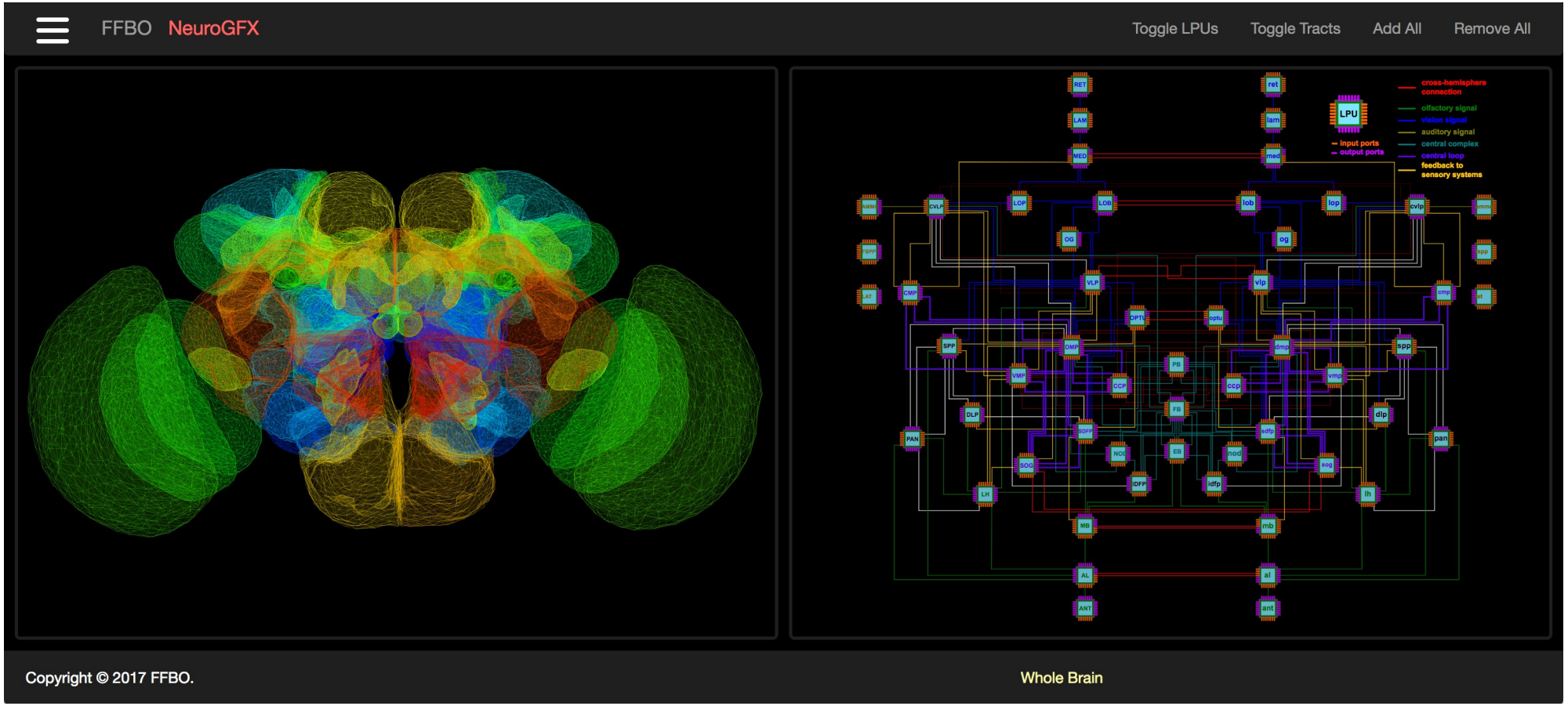
The final result can be tagged with a unique name (e.g. “EBdemo_step4”):
https://neuronlp.fruitflybrain.org/index.html?tag=EBdemo_step4

Additional Demos are available in the Exercises and on the NeuroNLP webpage under NeuroNLP >>> Demos.

NeuroGFX: A Graphical Function Explorer for Fly Circuits

https://neurogfx.fruitflybrain.org

A set of highly intuitive tools to execute and explore the function of neural circuit models



Neural Circuit Function at Whole Brain Level

The fruit fly brain is decomposed into some 50 neuropils, and they are shown on the left. The circuit diagram of the network of Local Processing Units, i.e., model abstractions of neuropils, is shown on the right.

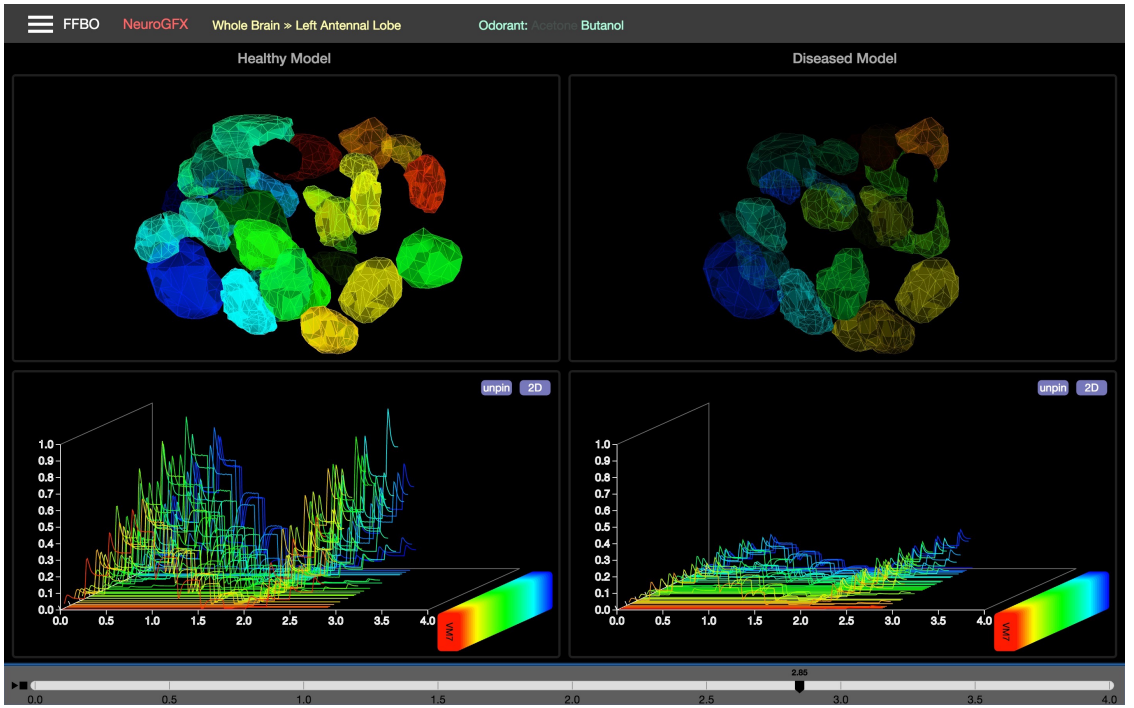
Additional Links:

- Neural Circuit Function at Neuropil Level: Antennal Lobe
- Neural Circuit Function at Local Circuit Level: A cartridge in the Lamina

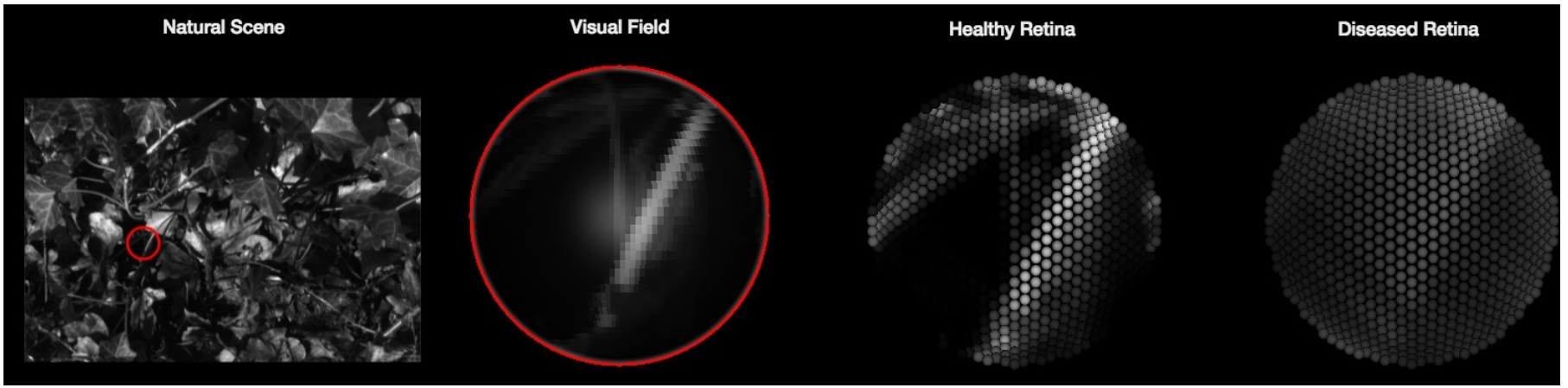
NeuroAPPs: Fly Brain Applications

Early Olfactory System Response in a Parkinson's Disease Model

The prototype extends healthy antennal lobe implementation to the emulation of to pathological states of the olfactory system due to an excess release of GABA.



Early Visual System Response in a Parkinson's Disease Model



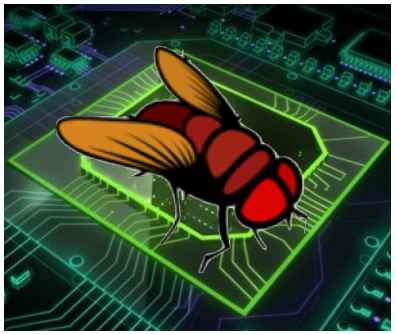
A model of the retina with a novel adaptive photoreceptor capable of accurately reproducing visual responses under a wide range of stimuli.

Under The Hood

Representation and manipulation of neural circuits

NeuroArch

Massively parallel execution of neural circuits on GPUs



Neurokernel

An integrative Graph dB for Representation and Querying of Fruit Fly Brain Circuits

NeuroArch (proposed in Neurokernel RFC #5) is a graph-based database that

- supports integration of biological and modeling data,
- facilitates the generation of executable models that are compatible with Neurokernel.

Its interface is designed to allows users to perform sophisticated queries without having to explicitly specify complex query strings

An Open Source Platform for Emulating the Fruit Fly Brain

https://neurokernel.github.io

Neurokernel is a platform for the emulation of the fruit fly brain enabling the execution of arbitrarily defined circuit models on GPU clusters.

- Execution of arbitrarily defined circuit models on GPU clusters.
- Neurokernel API allows users to easily integrate models of different parts of the fly brain.
- Neurokernel Request for Comments (RFCs) are publicly accessible design proposals for major new component, accompanied with code. https://neurokernel.github.io/docs.html