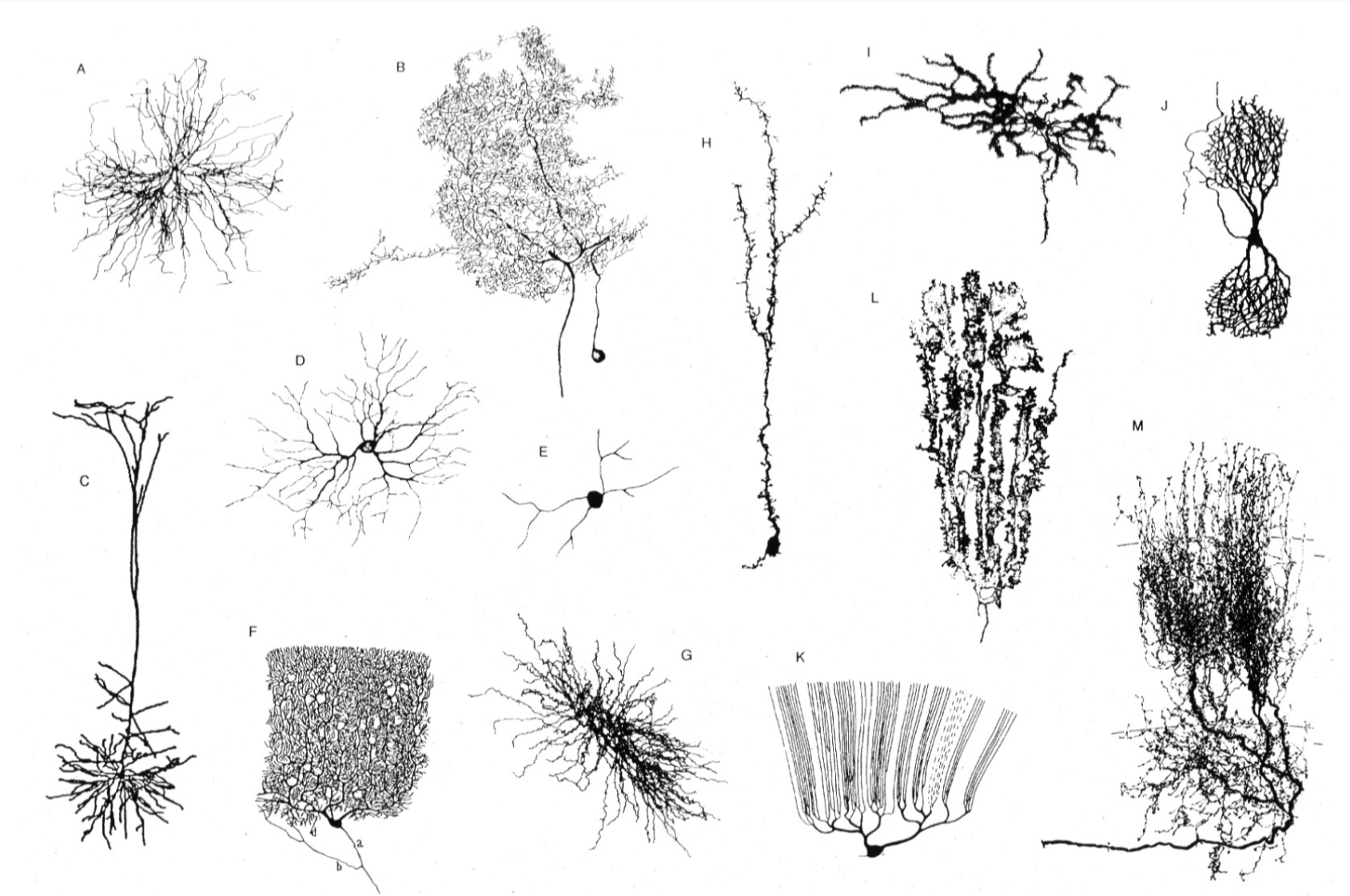
NeuroFedora

FOSS and Free/Open (neuro) Science

NeuroFedora contributors

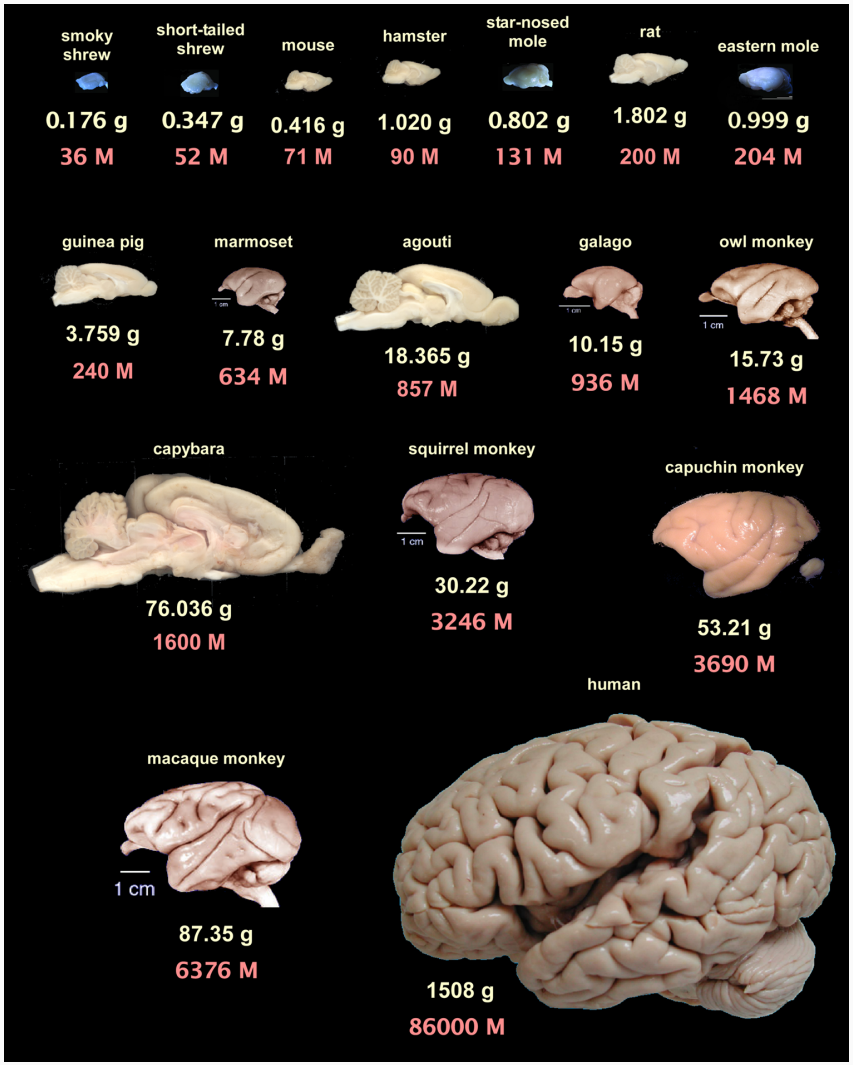
Problem statement: the brain

The brain: neurons



Dendrites, Oxford University Press, 2015; Modified from Mel, B.W. Neural Computation, 1994.

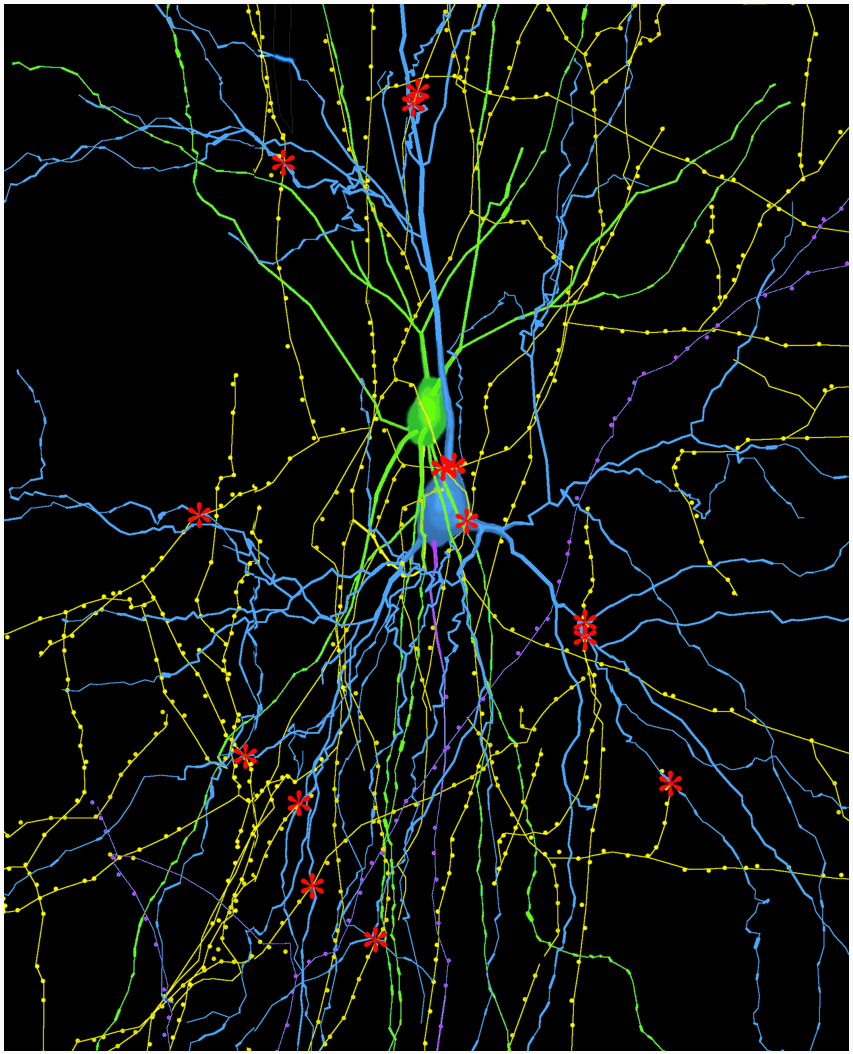
The brain: in numbers: neurons



- 86B neurons[1].

[1] Suzana Herculano-Houzel. "The human brain in numbers: a linearly scaled-up primate brain". In: *Frontiers in human neuroscience* 3 (2009), p. 31. DOI: 10.3389/neuro.09.031.2009

The brain: in numbers: synapses



- Thousands of connections between neurons (synapses)[2].
- Synapses are also of different types, and serve different functions.
- Synapses underlie learning[3].

[2] Image from The Gao lab, College of Medicine, Drexel University.

[3] D. O. Hebb. *The organization of behavior: A neuropsychological theory*. 1949

So, we want to know (among other things)

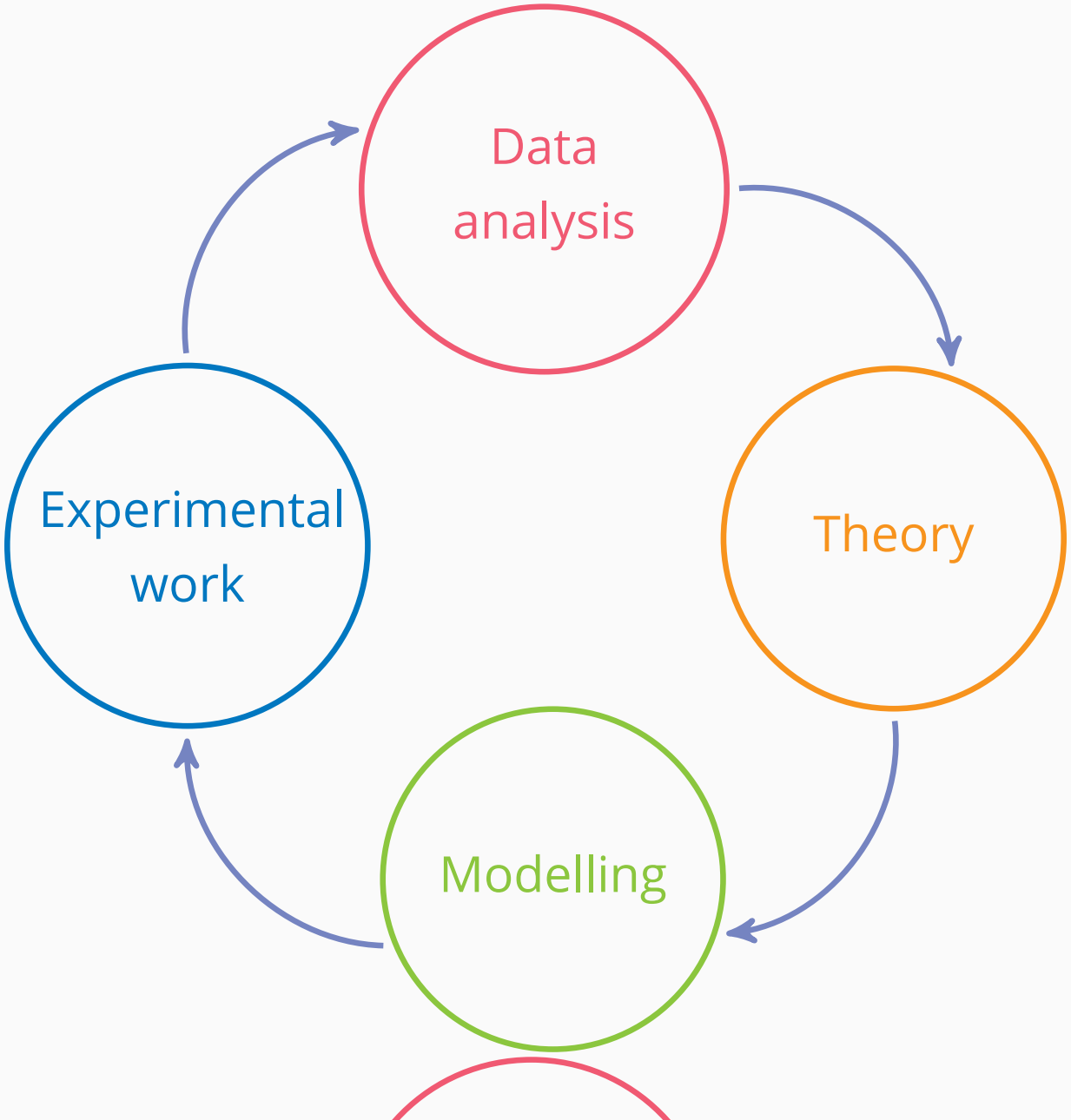
- how the brain functions (physiology),
- how it is structured (anatomy),
- about its chemicals (pharmacology, biochemistry),
- ...
- how it processes information (computational),
- about behaviours, and cognition (behavioural, cognitive),
- ...

with the aim of applying this knowledge to

- disease prevention and treatment,
- ...
- brain inspired computing,
- ...
- philosophy and consciousness,

How: research pipeline

General workflow



Tools of the trade

Experimental:

- EEG, ECoG, intracellular and extracellular single and multi neuron recording,
- CT, DOI, MRI, f-MRI, MEG, PET,

Data analysis:

- Statistics,
- Machine Learning, Big Data, Deep learning,

Theory and modelling:

- Simulators of all kinds,

Tools of the trade: II

Tools for the dissemination of knowledge[4]:

- visualisation,
- academic writing,
- non academic writing: blogging . . . ,
- podcasting,
- video making,
- creating teaching materials,

Collaborative tools and utilities.

[4] also to a non-specialist audience.

Free/Open (neuro) Science?

A familiar ideal

Free/Open science:
Everyone should have the freedom to share, study, and modify scientific material.

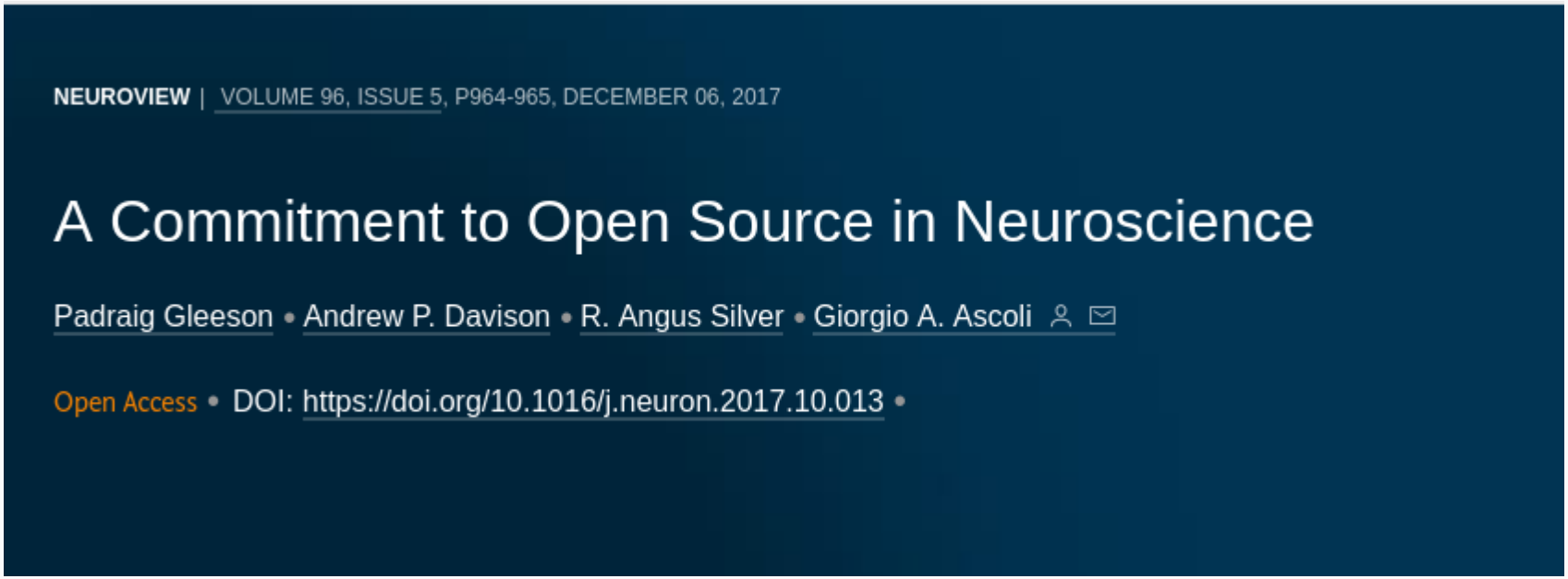
FOSS:
Everyone should have the freedom to share, study, and modify software[5].

Free/Open Science implicitly includes, and relies heavily on FOSS.

[5] Free software foundation

Now,

FOSS is becoming the standard in research[6].



[6] Open source for neuroscience

What can we, Fedora, do to help?

Neuroscience community: highly multidisciplinary

- various specialities: biologists, mathematicians, physicists, chemists, psychologists, . . . ,
- small proportion of trained software developers,

(Anecdotal) notes on development of research software

- often single developer, or small development teams,
- limited access to hardware/resources,
- limited code quality,
- limited use of established best practices,
- limited testing for correctness (!),
- limited maintenance, short-lived projects,
- complex dependency chains,
- lack of documentation and support,
- lack of community development know-how,

(Anecdotal) notes on users of research software

- waste time and effort installing (and reinstalling) their software stacks,
- are unaware of helpful development tools,
- rarely run test suites (!),
- rarely report bugs upstream,
- rarely send improvements upstream,

We, at Fedora, are in a unique position

- we liaison between upstream and users already,
- we follow best practices in software development,
- we have the infrastructure,
- we constantly work to grow the community,
- we learn from one another—train as we work,
- we disseminate information to end-users,

So, we started NeuroFedora

Primary goal:

- Provide a ready to use, integrated FOSS platform for neuroscientists[7].

Secondary/collateral goals:

- help improve the standard and maintenance of tools,
- help users develop software development skills,
- make neuroscience accessible to non-specialists,
- make Fedora the go-to distribution for neuroscience.

[7] Researchers, academics, hobbyists, anyone!

In essence,

NeuroFedora is:

- merely leveraging pre-existing community resources to a new domain of software.
- taking the community model of FOSS to neuroscience research,

NeuroFedora: current metrics

- less than a year old[8],
- 15 active contributors:
  - 10 package maintainers,
  - 5 designers, newcomers,
  - only 5 from a neuroscience background,
- software:
  - 105 packages ready to install[9].
  - ~160 in queue[10].
- poster presented at annual Computational Neuroscience Conference (CNS), 2019[11].

[8] in its second iteration

[9] src.fedoraproject.org: Neuro-SIG

[10] Pagure.io: Neuro-SIG: issues

[11] NeuroFedora blog: poster at CNS*2019

NeuroFedora: future plans

- make more software available,
  - via modularity,
  - via containers,
- improve documentation, and support,
- increase community,
  - convert research user base into FOSS contributors,
  - convert FOSS contributor base into users,

NeuroFedora: what you can do

Anything! It's just more of Fedora!

- packaging,
- testing
- containers,
- documentation,
- evangelism,
- marketing,
- design,
- . . . ,

So!

There's so much more to talk about

Mailing list: neuro-sig@lists.fedoraproject.org

IRC: #fedora-neuro

Telegram: t.me/NeuroFedora

Docs: neuro.fedoraproject.org

Blog: neurofedora.github.io

Pagure: neuro-sig/NeuroFedora

Fedora ♡ Science

There's more science in Fedora! Come to the HACKATHON!

- Astronomy SIG
- Bigdata SIG
- Machine Learning
- Electronic Lab
- Medical
- Sci-tech

Is your interest not listed? Start your own!

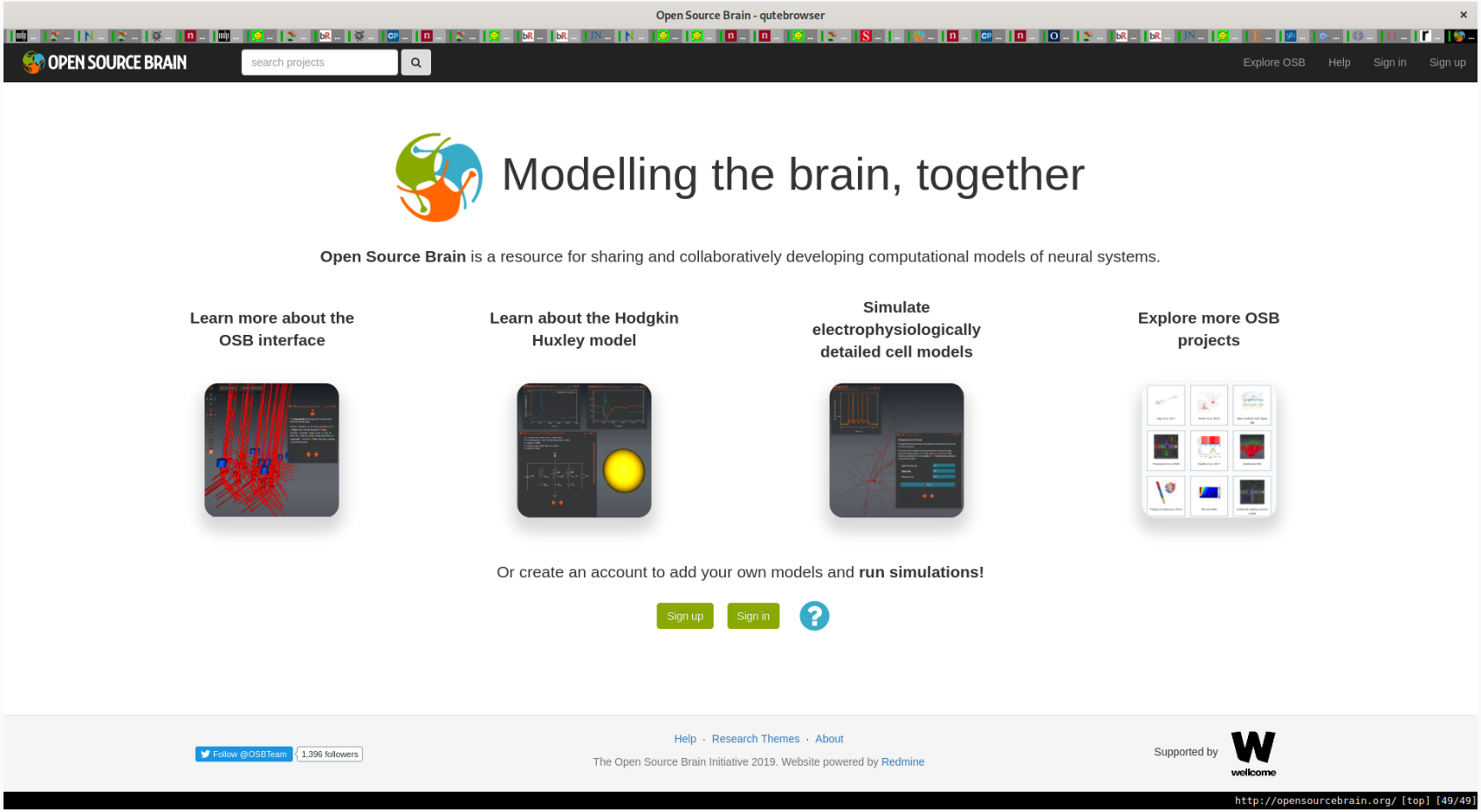
Myths

Myth 1

(Neuro) science is all about working on “core research”.

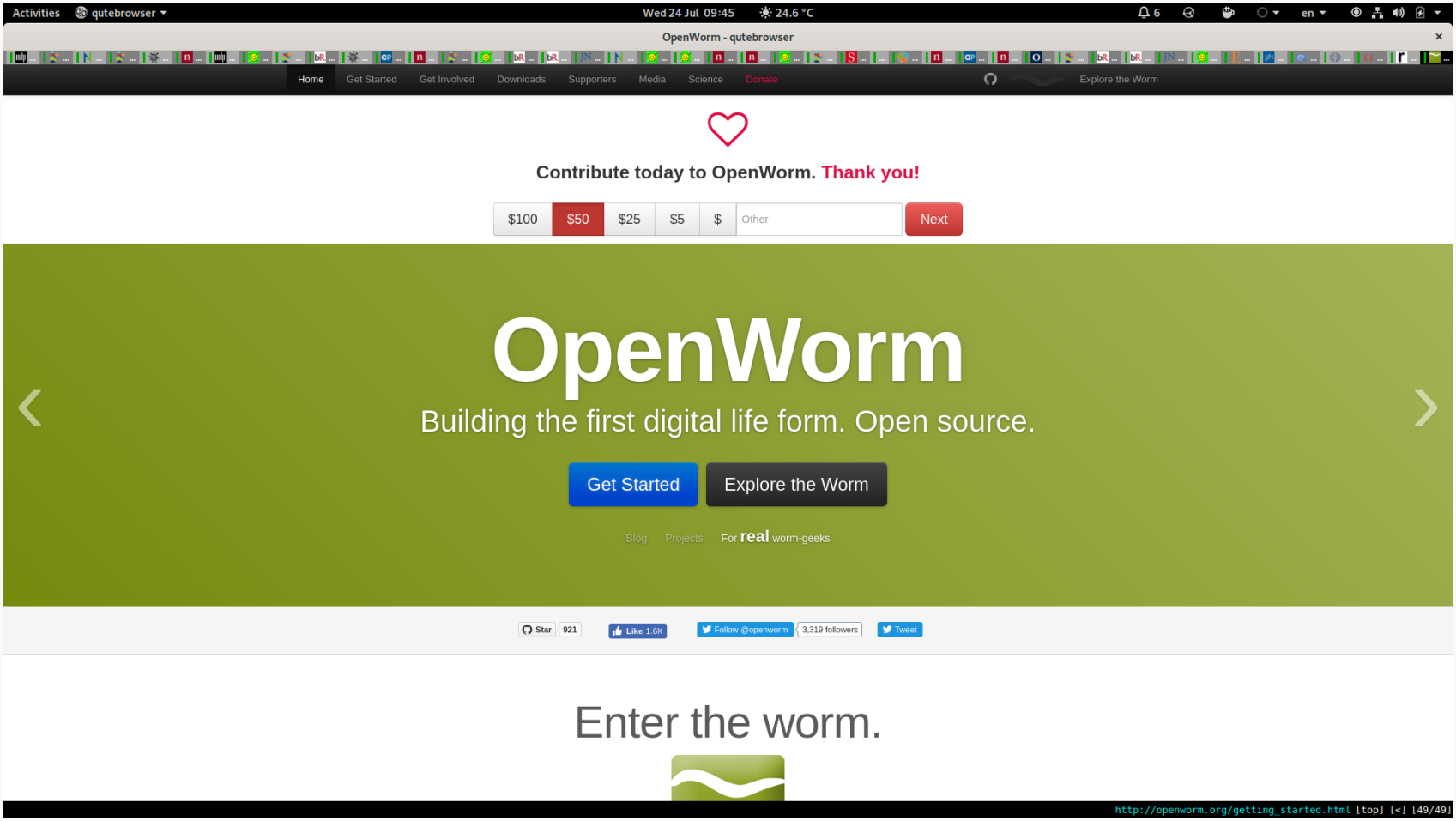
Wrong! There is more to (neuro) science!

Myth buster example: Open Source Brain



[12] opensourcebrain.org

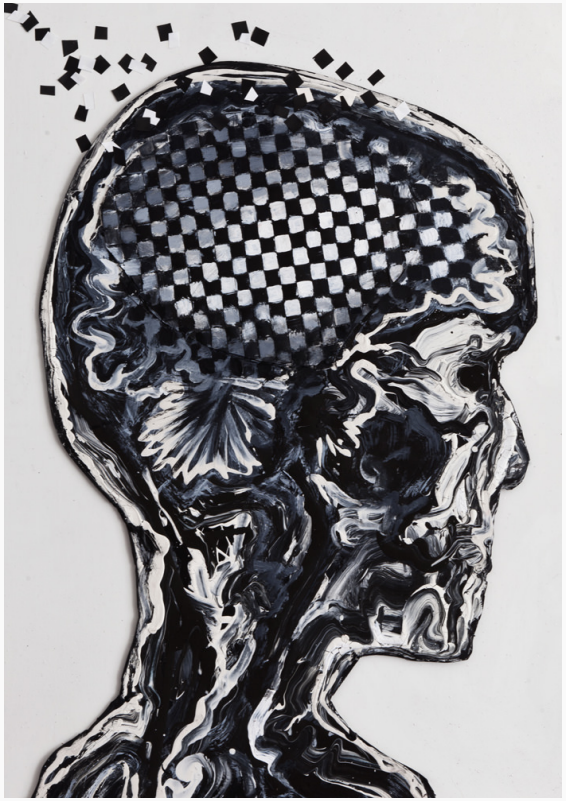
Myth buster example: OpenWorm



[13] openworm.org

Myth buster example: Science art

1: Snail: related to Dementia



2: Pieces of the Mind (2014)

[14] rebeccaivatts.com, © Rebecca Ivatts 2019

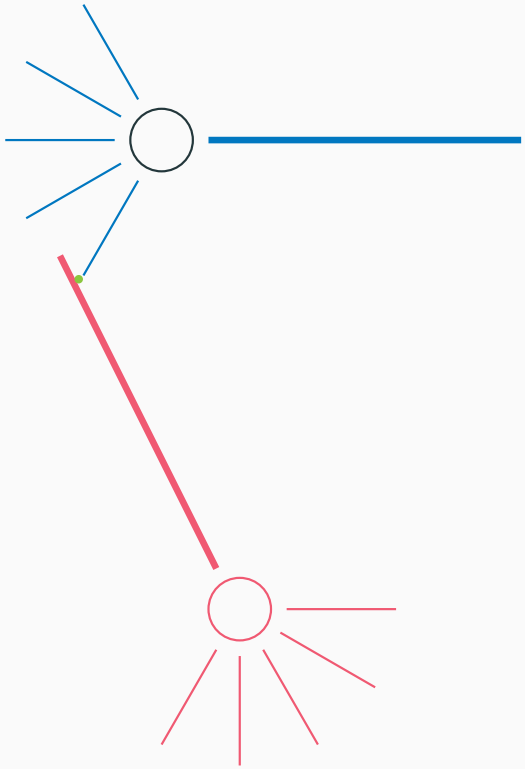
Myth 2

Only researchers can do (neuro) science. It's too hard.

Wrong! Everyone can do (neuro) science!

Myth buster example: understanding learning

Food: curry!



Smell A

Food: curry!

Myth buster example: an example simulation in NEST

```
# sudo dnf install python3-nest
import pylab
import nest
import nest.voltage_trace

weight = 20.0
delay = 1.0
stim = 1000.0

# create two neurons and a voltmeter
neuron1 = nest.Create("iaf_psc_alpha")
neuron2 = nest.Create("iaf_psc_alpha")
voltmeter = nest.Create("voltmeter")

# give the first neuron a stimulus, connect it to the second one, watch the second spike
nest.SetStatus(neuron1, {"I_e": stim})
nest.Connect(neuron1, neuron2, syn_spec={'weight': weight, 'delay': delay})
nest.Connect(voltmeter, neuron2)

nest.Simulate(100.0)

nest.voltage_trace.from_device(voltmeter)
nest.voltage_trace.show()
```

[16] nest-simulator.org