



# **NeuroFedora**

FOSS and Free/Open (neuro) Science

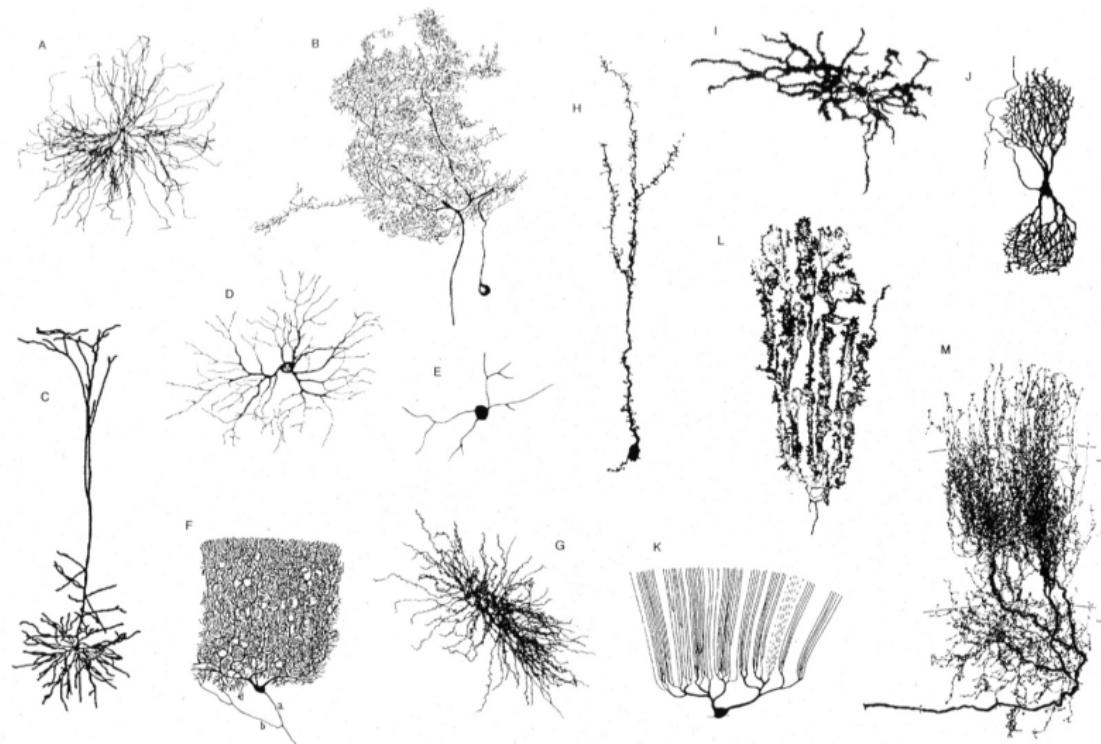
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NeuroFedora contributors

## **Problem statement: the brain**

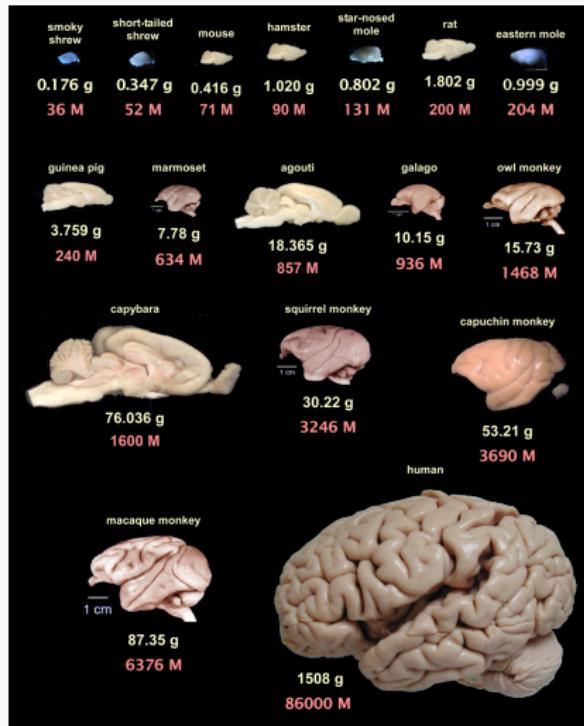
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# The brain: neurons



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

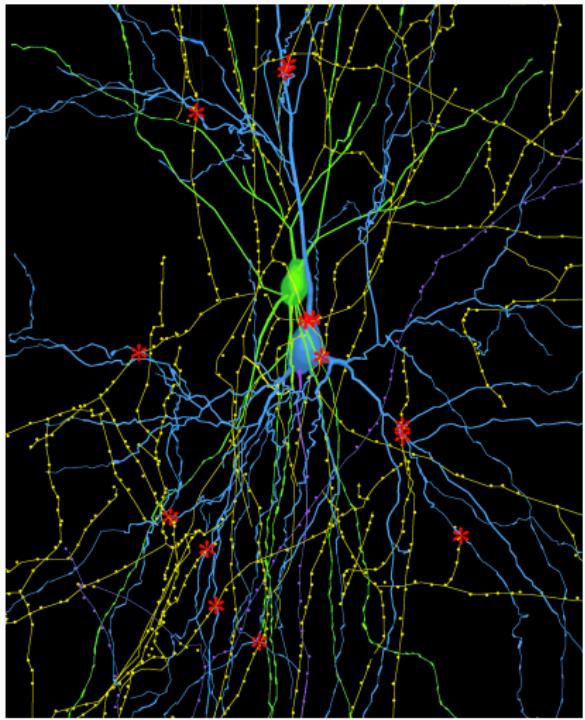
# The brain: in numbers: neurons



- 86B neurons<sup>1</sup>.

<sup>1</sup> 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](https://doi.org/10.3389/neuro.09.031.2009)

# The brain: in numbers: synapses



- Thousands of connections between neurons (synapses)<sup>2</sup>.
- Synapses are also of different types, and serve different functions.
- Synapses underlie learning<sup>3</sup>.

<sup>2</sup>Image from The Gao lab, College of Medicine, Drexel University.

<sup>3</sup>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**),
- ...

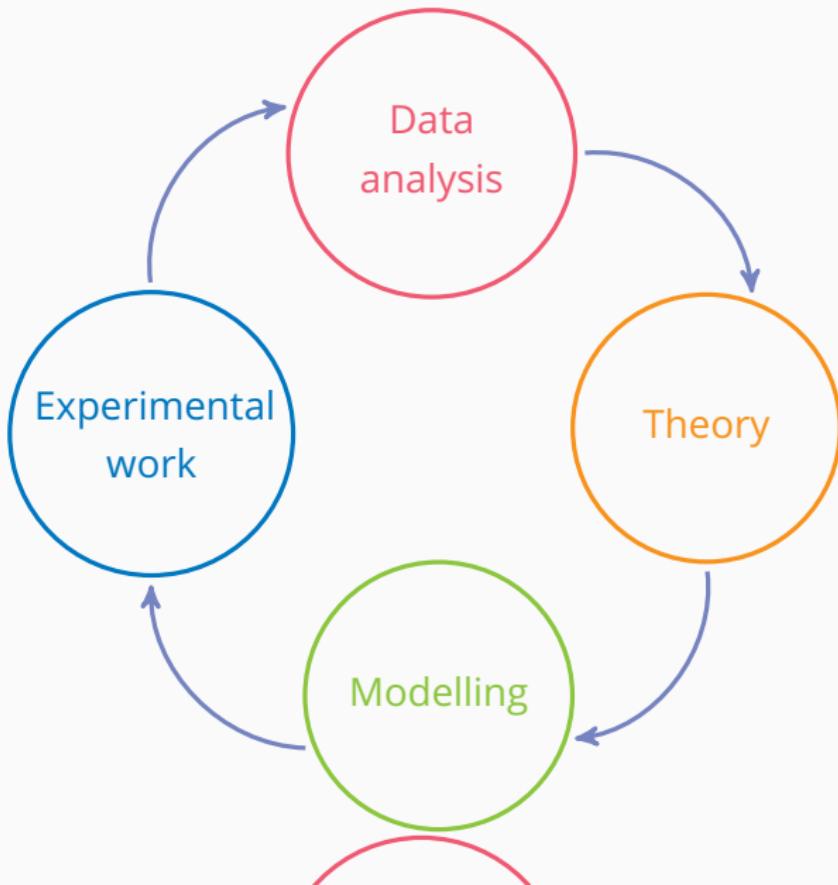
## with the aim of applying this knowledge to

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

## How: research pipeline

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## 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<sup>4</sup>:

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

Collaborative tools and utilities.

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<sup>4</sup>also to a non-specialist audience.

## Free/Open (neuro) Science?

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# 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<sup>5</sup>.

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

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<sup>5</sup> Free software foundation

Now,

FOSS is becoming the standard in research<sup>6</sup>.

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## A Commitment to Open Source in Neuroscience

Padraig Gleeson • Andrew P. Davison • R. Angus Silver • Giorgio A. Ascoli  

Open Access • DOI: <https://doi.org/10.1016/j.neuron.2017.10.013> •

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<sup>6</sup>Open source for neuroscience

**What can we, Fedora, do to help?**

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## 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<sup>7</sup>.

## 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.

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<sup>7</sup> 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<sup>8</sup>,
- 15 active contributors:
  - 10 package maintainers,
  - 5 designers, newcomers,
  - only 5 from a neuroscience background,
- software:
  - 105 packages ready to install<sup>9</sup>.
  - ~160 in queue<sup>10</sup>.
- poster presented at annual Computational Neuroscience Conference (CNS), 2019<sup>11</sup>.

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<sup>8</sup>in its second iteration

<sup>9</sup>[src.fedoraproject.org](http://src.fedoraproject.org): Neuro-SIG

<sup>10</sup>[Pagure.io](https://pagure.io): Neuro-SIG: issues

<sup>11</sup>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!**

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# There's so much more to talk about

Mailing list: [neuro-sig@lists.fedoraproject.org](mailto:neuro-sig@lists.fedoraproject.org)

IRC: #fedora-neuro

Telegram: [t.me/NeuroFedora](https://t.me/NeuroFedora)

Docs: [neuro.fedoraproject.org](https://neuro.fedoraproject.org)

Blog: [neurofedora.github.io](https://neurofedora.github.io)

Pagure: [neuro-sig/NeuroFedora](https://pagure.io/neuro-sig/NeuroFedora)

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

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## Myth 1

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

Wrong! There is more to (neuro) science!

# Myth buster example: Open Source Brain

The screenshot shows the Open Source Brain website. At the top, there's a navigation bar with a search bar and links for "Explore OSB", "Help", "Sign in", and "Sign up". Below the header, there's a logo of a brain and the tagline "Modelling the brain, together". A sub-headline explains: "Open Source Brain is a resource for sharing and collaboratively developing computational models of neural systems." There are four main sections: "Learn more about the OSB interface" (with a thumbnail of a brain model), "Learn about the Hodgkin Huxley model" (with a thumbnail of a simulation interface), "Simulate electrophysiologically detailed cell models" (with a thumbnail of a complex simulation interface), and "Explore more OSB projects" (with a thumbnail of a grid of various project icons). At the bottom, there's a call to action: "Or create an account to add your own models and run simulations!" followed by "Sign up" and "Sign in" buttons, and a help icon. The footer includes social media links ("Follow @OSB\_Book" and "1,396 followers"), a copyright notice ("The Open Source Brain Initiative 2019. Website powered by Redmine"), and a "Supported by" section featuring the Wellcome Trust logo.

Open Source Brain - qutebrowser

OPEN SOURCE BRAIN search projects

Explore OSB Help Sign in Sign up

Modelling the brain, together

Open Source Brain is a resource for sharing and collaboratively developing computational models of neural systems.

Learn more about the OSB interface

Learn about the Hodgkin Huxley model

Simulate electrophysiologically detailed cell models

Explore more OSB projects

Or create an account to add your own models and run simulations!

Sign up Sign in ?

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Help · Research Themes · About

The Open Source Brain Initiative 2019. Website powered by Redmine

Supported by

W wellcome

<http://opensourcebrain.org/> [top] [49/49]

# Myth buster example: OpenWorm

The screenshot shows a Linux desktop environment with a terminal window titled "Activities" and a browser window titled "OpenWorm - qutebrowser". The browser displays the OpenWorm homepage. The page features a red heart icon and the text "Contribute today to OpenWorm. Thank you!". Below this is a donation input field with buttons for \$100, \$50, \$25, \$5, and "Other". A large green banner in the center contains the text "OpenWorm" in white, with the subtitle "Building the first digital life form. Open source." underneath. It includes "Get Started" and "Explore the Worm" buttons. Below the banner are links for "Blog", "Projects", and "For real worm-geeks". Social media icons for StumbleUpon, Facebook, and Twitter are at the bottom. A large call-to-action button at the bottom says "Enter the worm." with a green wavy logo.

# Myth buster example: Science art



1: Snail: related to Dementia



2: Pieces of the Mind (2014)

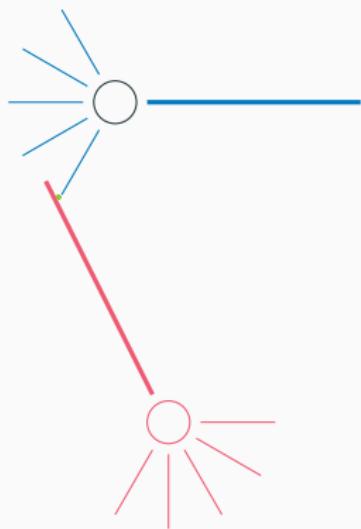
## Myth 2

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()
```