



## NeuroFedora

FOSS and Free/Open (neuro) Science

NeuroFedora contributors

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### Notes

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## Problem statement: the brain

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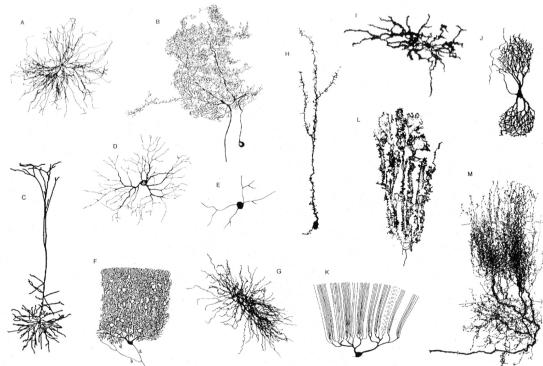
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## The brain: neurons



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

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### Notes

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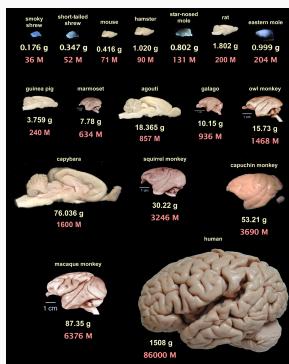
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## The brain: in numbers: neurons



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

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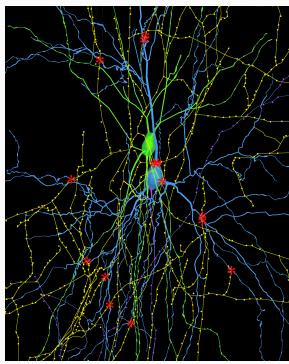
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<sup>1</sup>Suzana Herculano-Houzel. "The human brain in numbers: a linearly scaled-up primate brain". In: *Frontiers in human neuroscience* 3 (2009), p. 31. doi: 10.3389/neuro.09.031.2009

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## 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

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## 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),
- ...

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## with the aim of applying this knowledge to

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

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## How: research pipeline

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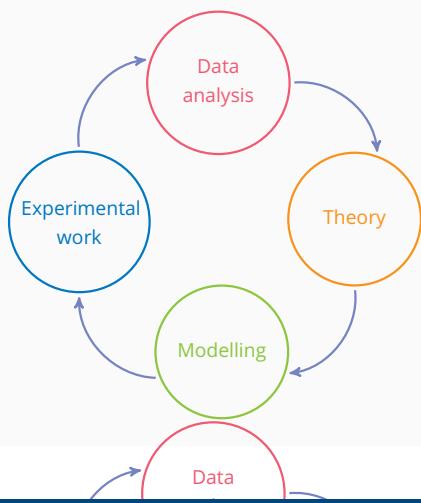
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## General workflow



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## 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,

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## 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.

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

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## 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.

<sup>5</sup>Free software foundation

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## Now,

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

NEUROVIEW | VOLUME 96, ISSUE 5, P964-965, DECEMBER 06, 2017

### 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> •

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

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

## Neuroscience community: highly multidisciplinary

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

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## (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**,

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## (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**,

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## 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,

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## 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**.

<sup>7</sup>Researchers, academics, hobbyists, anyone!

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## NeuroFedora is:

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

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## 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>.

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

<sup>9</sup>src.fedoraproject.org: Neuro-SIG

<sup>10</sup>Pagure.io: Neuro-SIG: issues

<sup>11</sup>NeuroFedora blog: poster at CNS\*2019

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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,

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**NeuroFedora: what you can do**

Anything! It's just more of Fedora!

- packaging,
  - testing
  - containers,
  - documentation,
  - evangelism,
  - marketing,
  - design,
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## Notes

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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)

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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!

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## Myths

## Myth 1

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

Wrong! There is more to (neuro) science!

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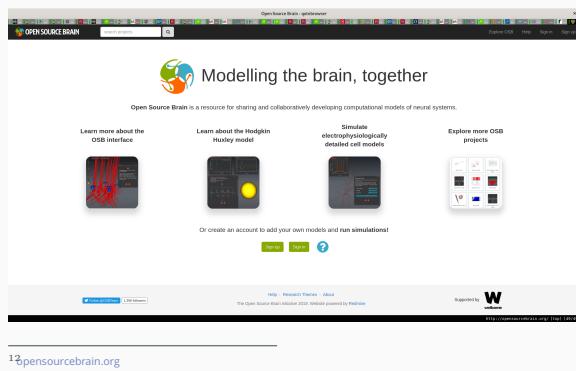
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## Myth buster example: Open Source Brain



The screenshot shows the homepage of the Open Source Brain website. At the top, there's a navigation bar with links for "Home", "About", "Log In", and "Sign Up". Below the navigation, a large banner features the text "Modelling the brain, together" and "Open Source Brain is a resource for sharing and collaboratively developing computational models of neural systems." It includes four main sections: "Learn more about the OSB interface", "Learn about the Hodgkin-Huxley model", "Simulate electrophysiologically detailed cell models", and "Explore more OSB projects". Below these sections, there's a button to "Create an account" and a link to "Documentation". At the bottom of the page, there's a footer with links for "Help", "Research Themes", "About", and "Supported by". The URL "12.opensourcebrain.org" is visible at the bottom left.

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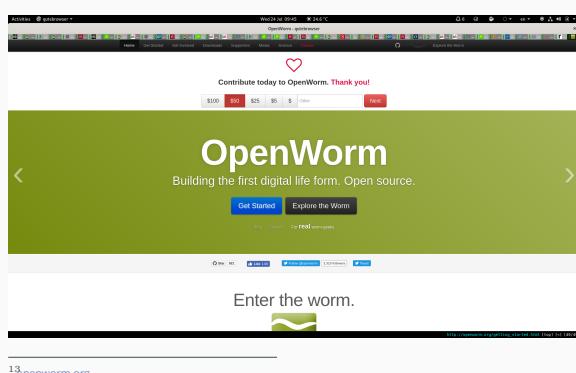
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## Myth buster example: OpenWorm



The screenshot shows the homepage of the OpenWorm website. At the top, there's a navigation bar with links for "Home", "About", "Contact", "Help", "Blog", and "GitHub". Below the navigation, a large banner features the text "OpenWorm" and "Building the first digital life form, Open source.". It includes two buttons: "Get Started" and "Explore the Worm". Below the banner, there's a section titled "Enter the worm." with a small image of a worm. At the bottom of the page, there's a footer with links for "Help", "Contact", "About", "Blog", and "GitHub". The URL "13.openworm.org" is visible at the bottom left.

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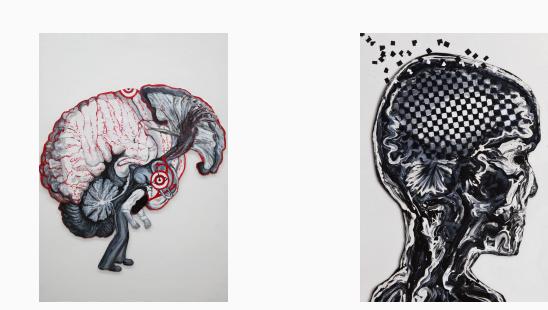
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## Myth buster example: Science art



1: Snail: related to Dementia

2: Pieces of the Mind (2014)

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## Myth 2

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

Wrong! Everyone can do (neuro) science!

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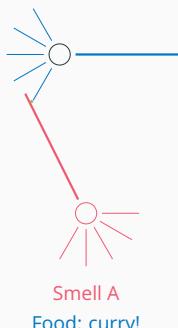
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## Myth buster example: understanding learning

Food: curry!



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## 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)

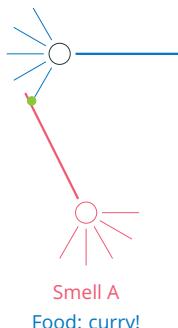
nest.Simulate(100.0)

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

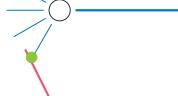
<sup>16</sup>[nest-simulator.org](http://nest-simulator.org)

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Smell A  
Food: curry!



Smell A  
Food: curry!



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