



NeuroFedora

FOSS and Free/Open (neuro) Science

NeuroFedora contributors



Problem statement: the brain

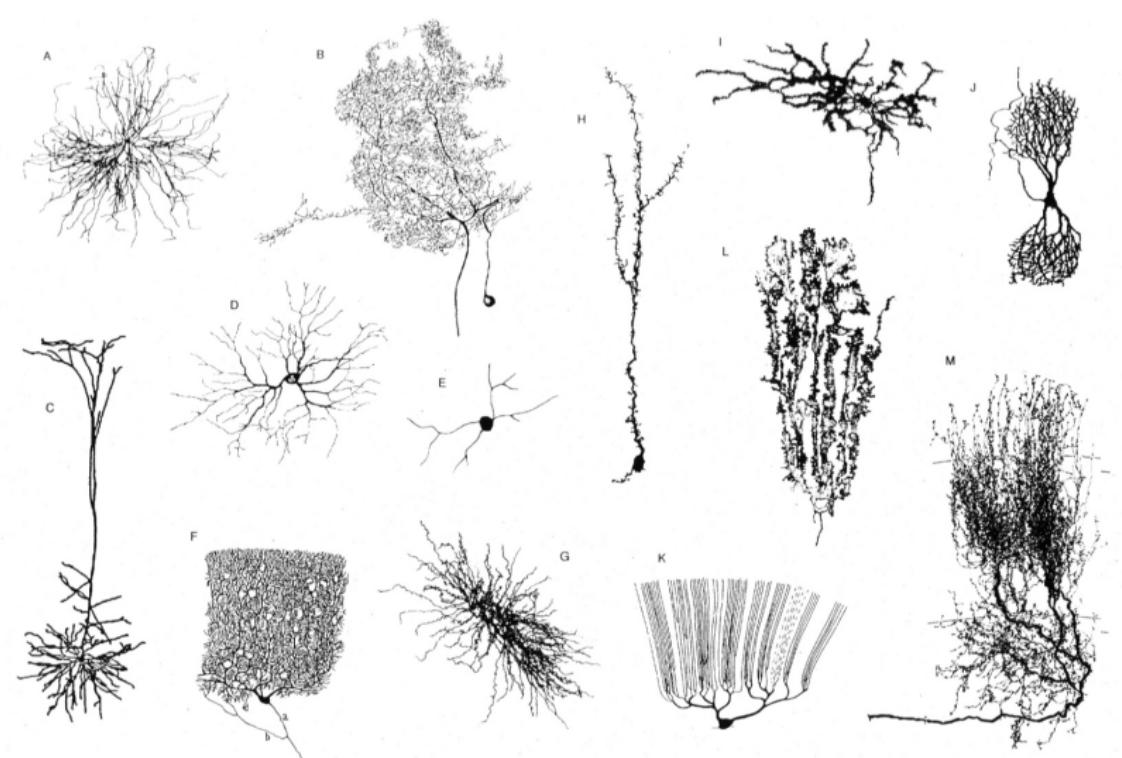
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└ Problem statement: the brain

2019-07-25

Problem statement: the brain

The brain: neurons



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

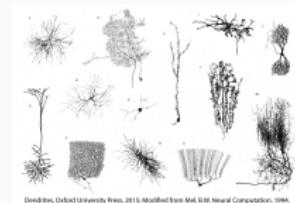
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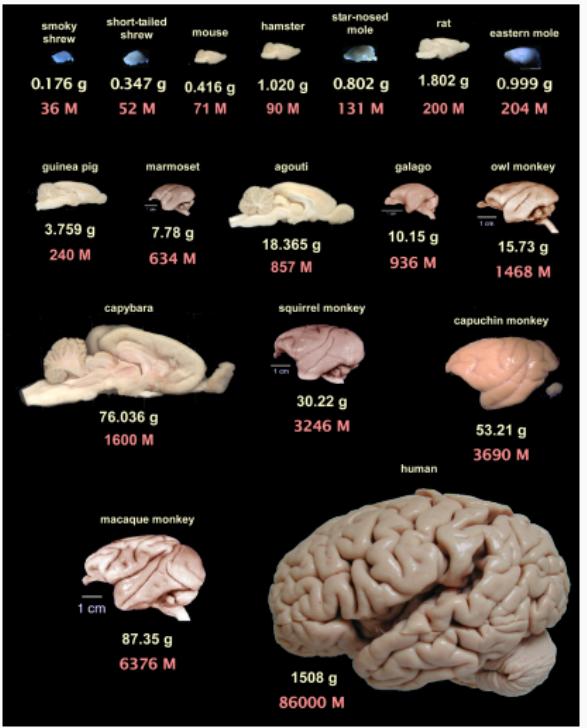
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The brain: neurons



1. The brain is composed of specialised cells that enable it to process information by the use of electrical impulses
2. As the figure shows, these cells, neurons, have specialised into many many types. They serve different functions, include different proteins and markers, and can be classified in many different ways.

The brain: in numbers: neurons



- 86B neurons¹.

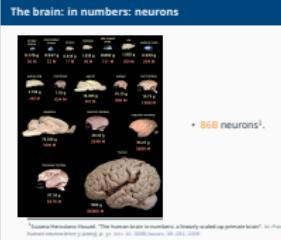
¹ Suzana Herculano-Houzel. "The human brain in numbers: a linearly scaled-up primate brain". In: *Frontiers in human neuroscience* 3 (2009), p. 31. DOI: 10.3389/neuro.09.031.2009

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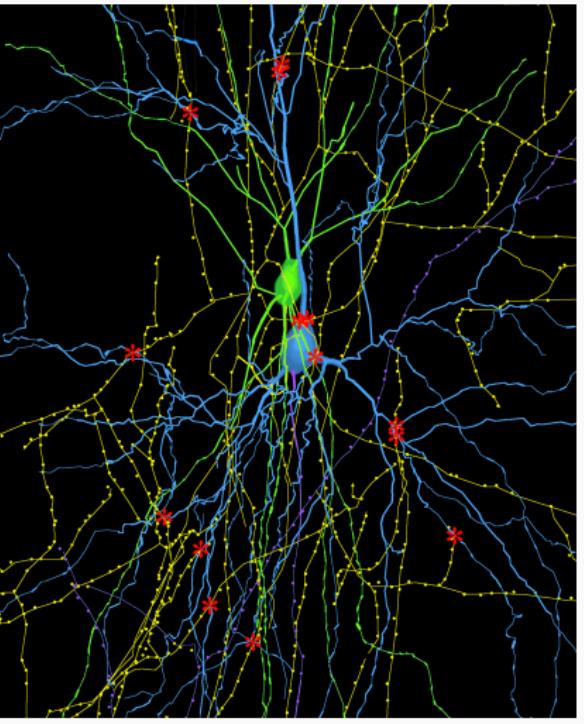
└ The brain: in numbers: neurons

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1. The most recent estimate puts the number of neurons in the human brain at 86B.

The brain: in numbers: synapses



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

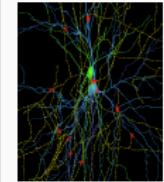
²Image from The Gao lab, College of Medicine, Drexel University.

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

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└ The brain: in numbers: synapses

1. Each neuron connects with thousands of other neurons, forming a massive network.
2. So, the brain can be thought of as a massively parallel processor.

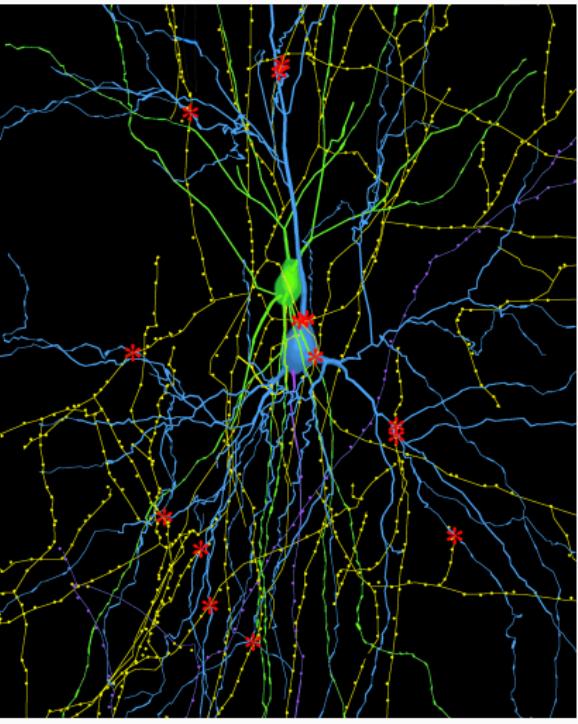


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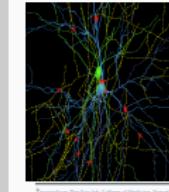
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- how the brain functions ([physiology](#)),
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immediate clinical applications, immediate technological
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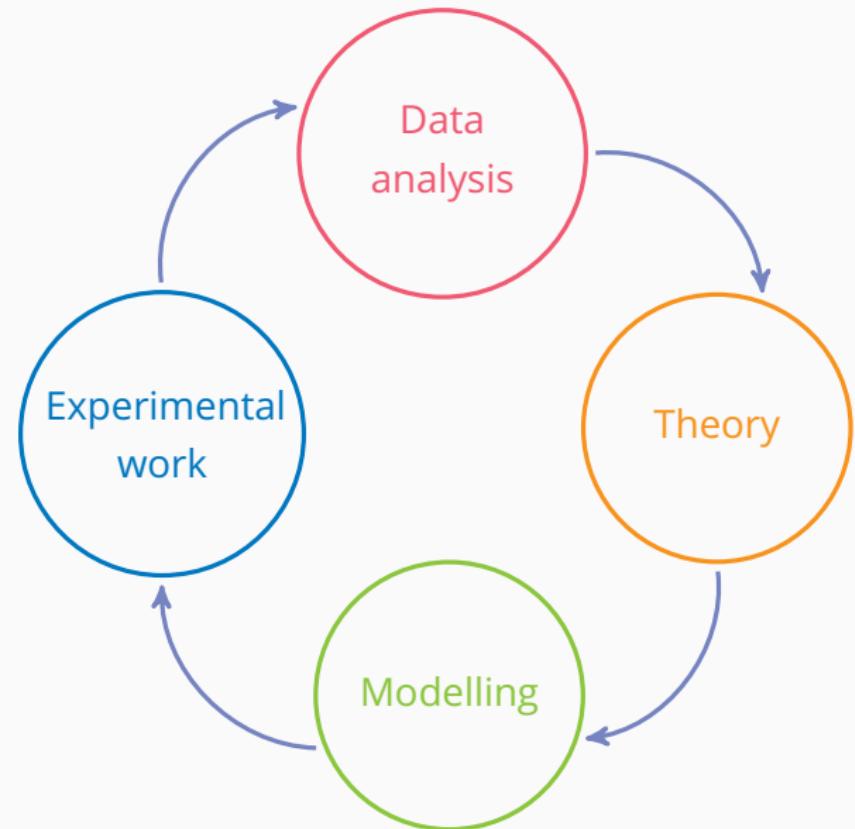
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How: research pipeline

General workflow



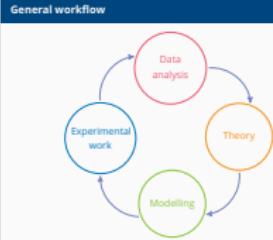
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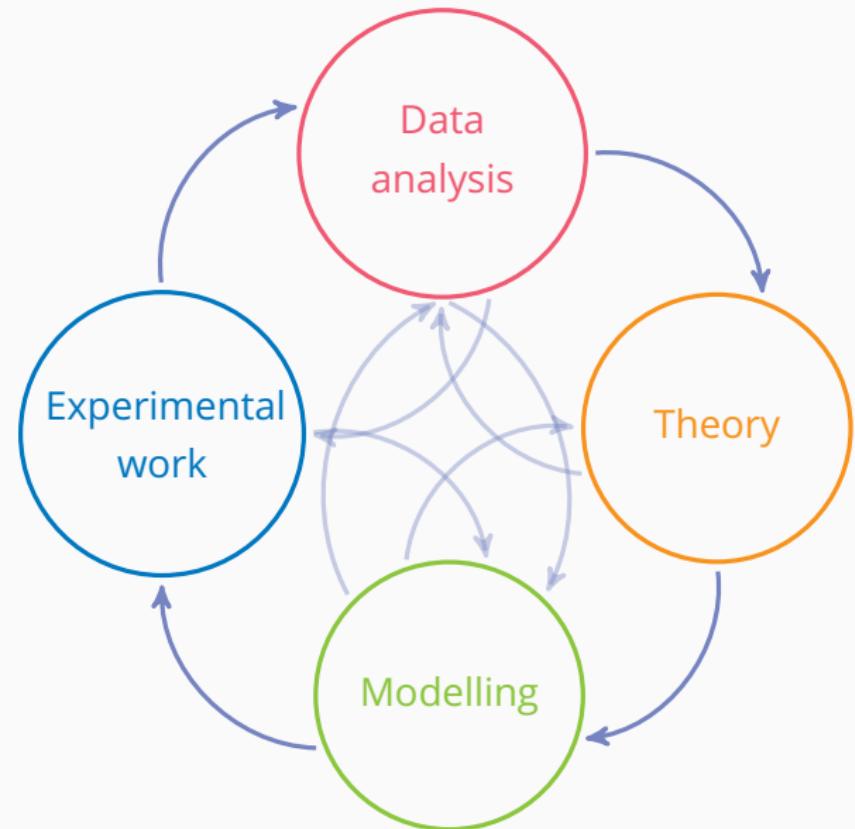
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└ How: research pipeline

└ General workflow

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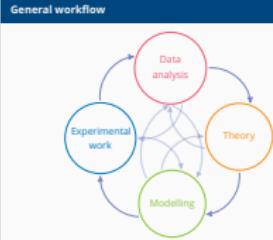
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└ How: research pipeline

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- EEG, ECoG, intracellular and extracellular single and multi neuron recording,
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Tools of the trade

Experimental:

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└ How: research pipeline

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1. Lots of hardware and software is required for basic neuroscience research.

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Tools for the dissemination of knowledge⁴:

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

⁴also to a non-specialist audience.

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Collaborative tools and utilities.

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1. Often ignored, but not less important

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Free/Open (neuro) Science?

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└ Free/Open (neuro) Science?

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Free/Open (neuro) Science?

A familiar ideal

Free/Open science:

Everyone should have the freedom to share, study, and modify scientific material.

⁵ Free software foundation

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└ Free/Open (neuro) Science?

└ A familiar ideal

1. This includes all research related activities, tools, and output, not only source code.

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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** software⁵.

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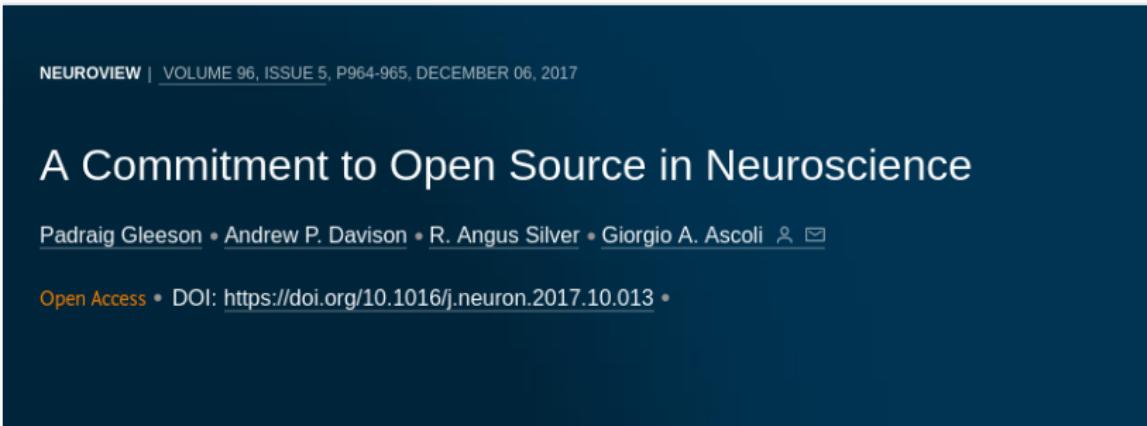
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https://neurofedora.org

Now,

FOSS is becoming the standard in research⁶.

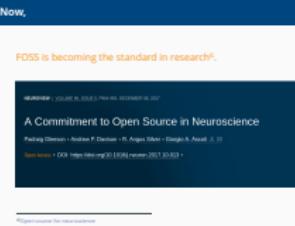


⁶Open source for neuroscience

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└ Free/Open (neuro) Science?

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└ Now,



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What can we, Fedora, do to help?

Neuroscience community: highly multidisciplinary

- **various specialities:** biologists, mathematicians, physicists, chemists, psychologists,

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(Anecdotal) notes on development of research software

- often **single developer**, or small development teams,

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└ What can we, Fedora, do to help?

└ (Anecdotal) notes on development of
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1. Give how interdisciplinary neuroscience is, most researchers are NOT trained in development
2. This implies, and this is based on anecdotal evidence, that the software used in research is not of the best quality

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1. The other side of the bridge is the users
2. Because they aren't trained, they have a hard time setting up and using the software
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- we liaison between upstream and users already,

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Primary goal:

- Provide a ready to use, integrated FOSS platform for neuroscientists⁷.

⁷Researchers, academics, hobbyists, anyone!

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- help **improve the standard and maintenance of tools**,
- help users **develop software development skills**,
- **make neuroscience accessible** to non-specialists,

⁷Researchers, academics, hobbyists, anyone!

NeuroFedora

└ What can we, Fedora, do to help?

└ So, we started NeuroFedora

2019-07-25

So, we started NeuroFedora

Primary goal:

- Provide a **ready to use, integrated FOSS platform** for neuroscientists⁷.

Secondary/collateral goals:

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NeuroFedora: current metrics

- less than a year old⁸,

⁸in its second iteration

⁹src.fedoraproject.org: Neuro-SIG

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

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NeuroFedora: future plans

- make more software available,
 - via modularity,
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NeuroFedora

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2019-07-25

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NeuroFedora: what you can do

Anything! It's just more of Fedora!

NeuroFedora

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└ NeuroFedora: what you can do

2019-07-25

NeuroFedora: what you can do

Anything! It's just more of Fedora!

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



NeuroFedora

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2019-07-25



So!

NeuroFedora
└ So!

2019-07-25

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

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

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1. All the resources are already available in the community—all one needs to do is find others who share interests and start working!

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Is your interest not listed? Start your own!

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2019-07-25

Myths

Myth 1

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

2019-07-25

NeuroFedora
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1. The learning curve is similar to what non-techies experience when they try to join FOSS. It takes similar effort to gain the required domain specific knowledge.

Myth 1

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

Wrong! There is more to (neuro) science!

2019-07-25

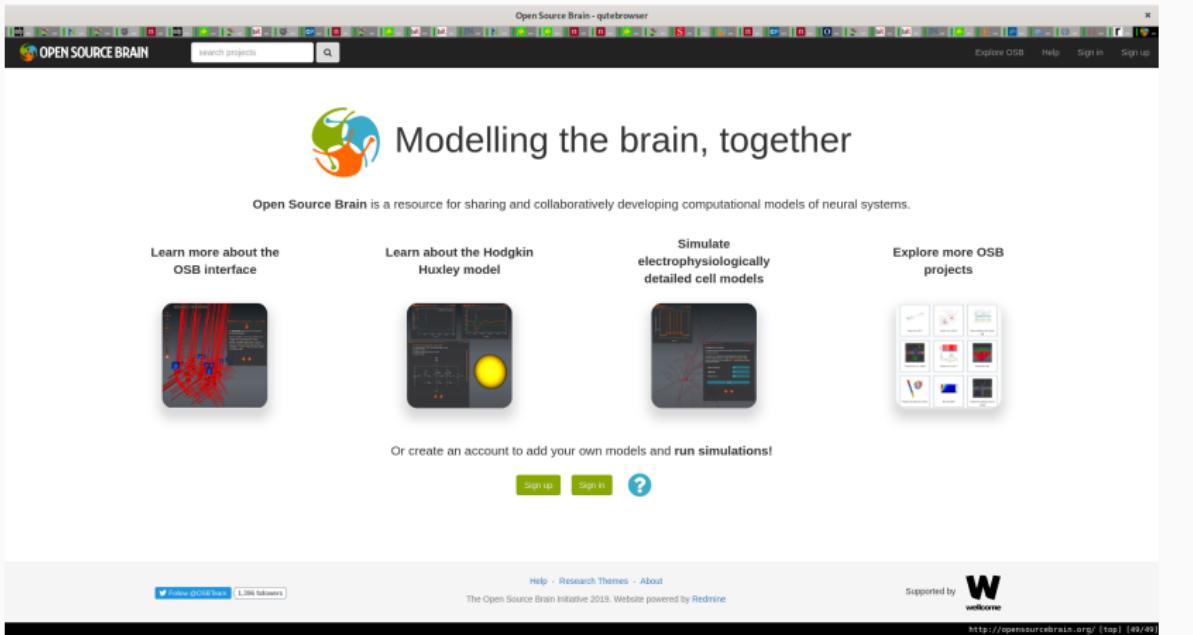
NeuroFedora
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Myth buster example: Open Source Brain

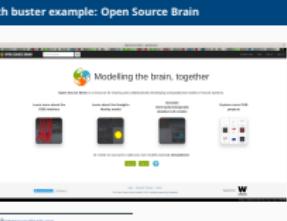


The screenshot shows the homepage of the Open Source Brain website. At the top, there's a navigation bar with links for 'Explore OSB', 'Help', 'Sign in', and 'Sign up'. Below the header, a large logo features a stylized brain with the text 'Modelling the brain, together'. A sub-headline states: 'Open Source Brain is a resource for sharing and collaboratively developing computational models of neural systems.' There are four main call-to-action buttons: 'Learn more about the OSB interface', 'Learn about the Hodgkin Huxley model', 'Simulate electrophysiologically detailed cell models', and 'Explore more OSB projects'. Each button has a corresponding thumbnail image. At the bottom, there's a section encouraging users to 'Or create an account to add your own models and run simulations!' with 'Sign up' and 'Log in' buttons, along with a help icon.

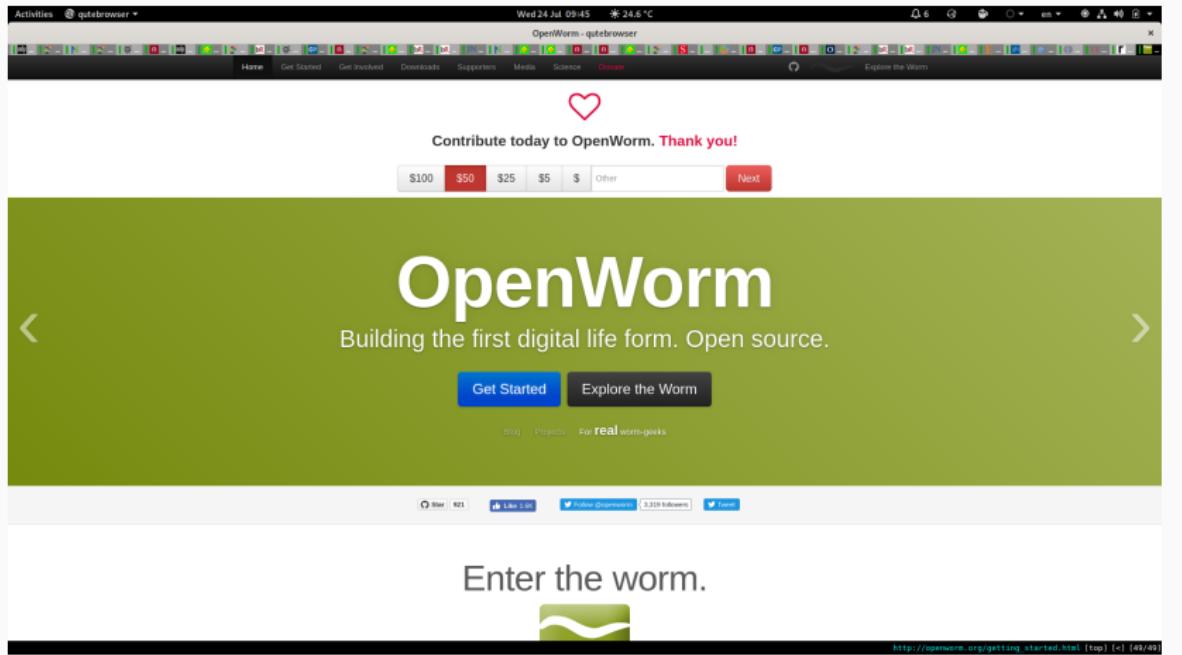
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└ Myths

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└ Myth buster example: Open Source Brain



Myth buster example: OpenWorm



13 openworm.org

NeuroFedora
└ Myths

2019-07-25

└ Myth buster example: OpenWorm



Myth buster example: Science art



1: Snail: related to Dementia



2: Pieces of the Mind (2014)



1: Snail: related to Dementia



2: Pieces of the Mind (2014)

Myth 2

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

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Myth 2

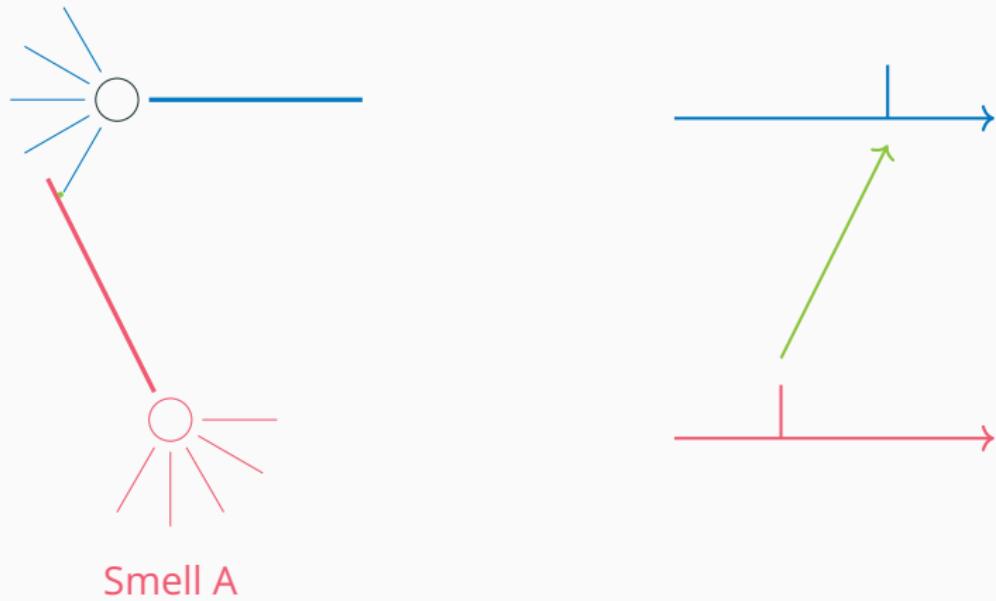
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Wrong! Everyone can do (neuro) science!

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Myth buster example: understanding learning

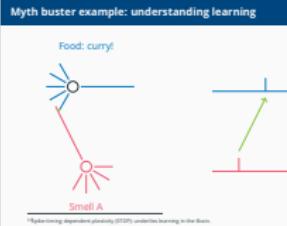
Food: curry!



¹⁵Spike-timing dependent plasticity (STDP): underlies learning in the Brain.

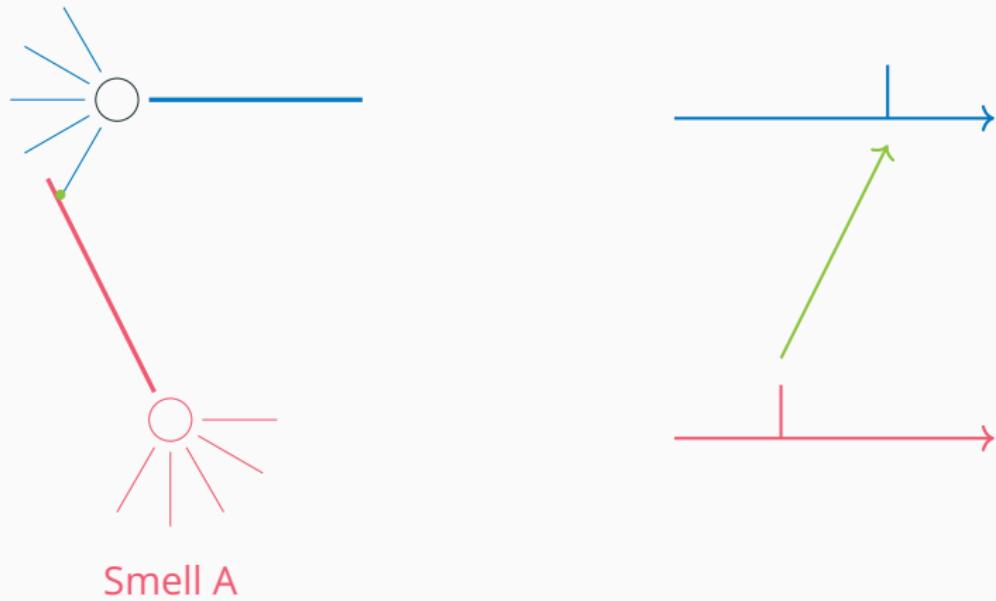
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1. We learn when synapses change in the brain
2. As an example, let's say we have a neuron that was activated by a smell.
3. Later, we found out that that was the smell of some food, say curry.
4. Because these neurons fired one after the other here, this synapse is strengthened.
5. When this happens repeatedly, the synapse is strengthened again and again.
6. Until, the faintest whiff of the smell reminds you of the food!
7. Of course, the more you look at it, the more information you find, but that doesn't mean that we can't study or apply it.



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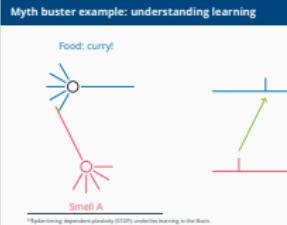
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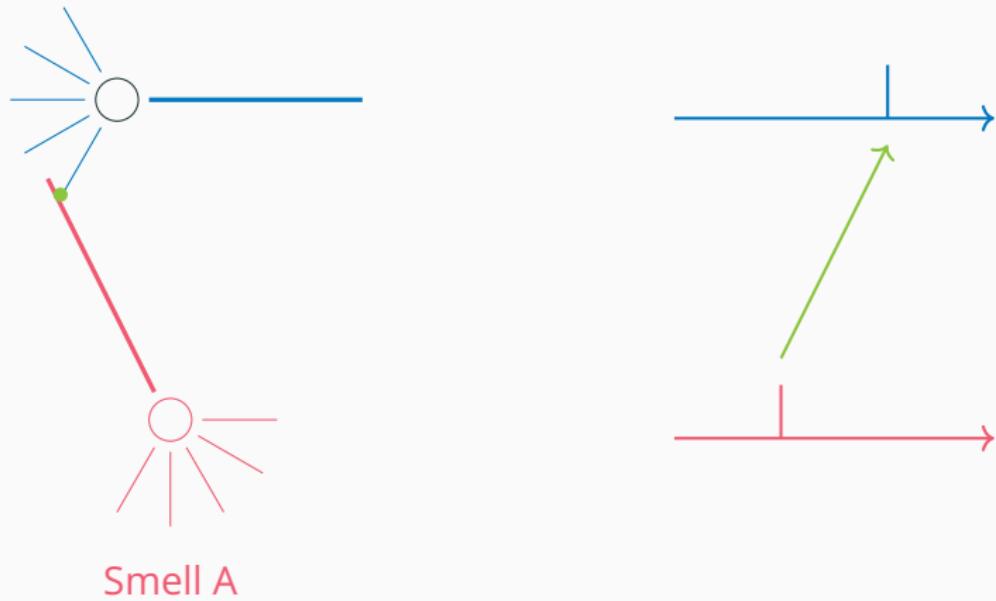
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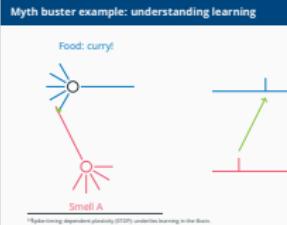
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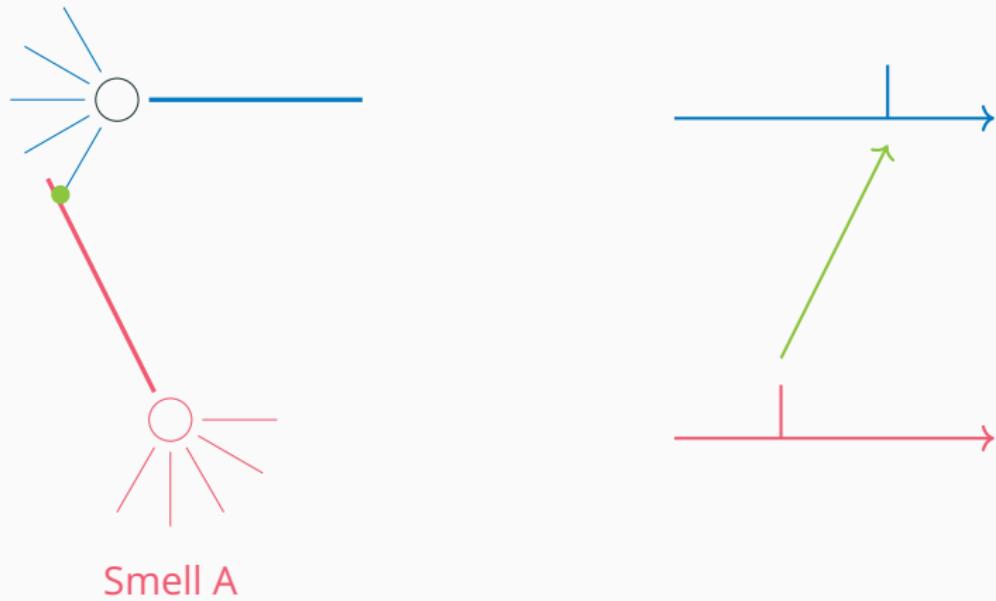
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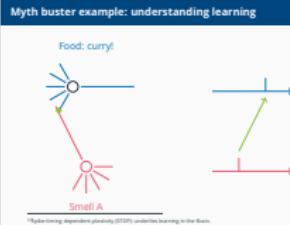
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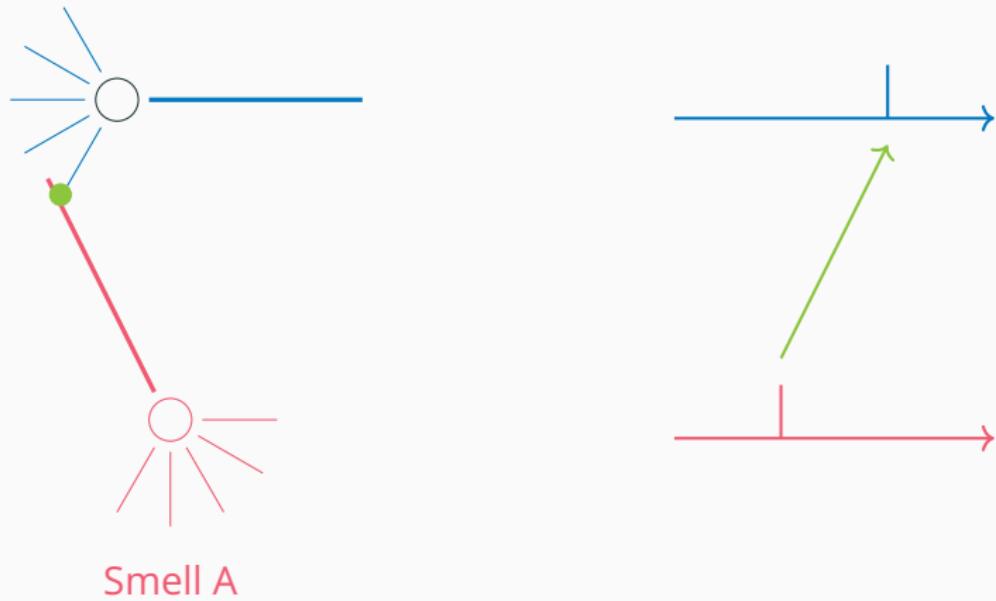
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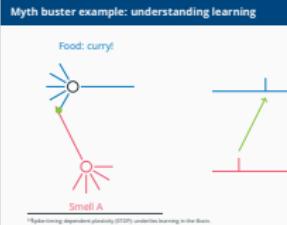
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Myth buster example: an example simulation in NEST

```
# 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()
```

¹⁶nest-simulator.org

2019-07-25

└ Myth buster example: an example simulation in NEST

1. This is all it takes to simulate two neurons that are connected through a synapse.
2. Of course, this is a simple example, but the point is—it's just programming with a little bit of domain knowledge.

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Here simulation.org
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