NeuroFedora

FOSS and Free/Open (neuro) Science

NeuroFedora contributors

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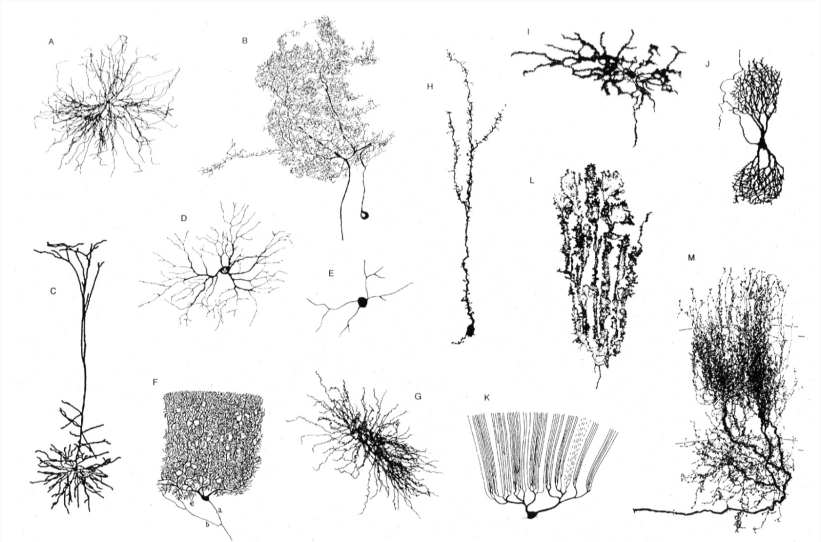
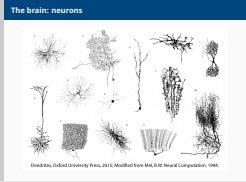
Problem statement: the brain

Problem statement: the brain

The brain: neurons

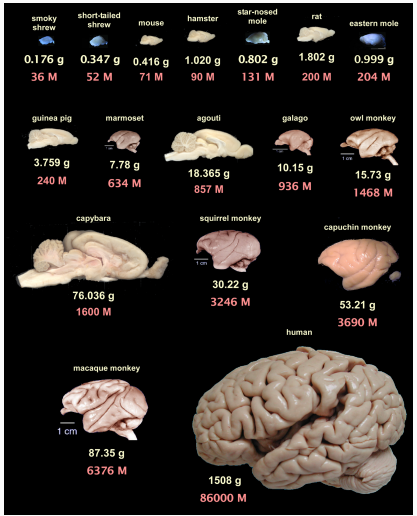


Dendrites, Oxford University Press, 2015; Modified from Mel, B.W. Neural Computation, 1994.



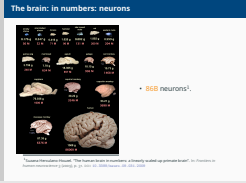
1. The brain is composed of specialised cells that enable it to process information by the use of electrical impulses
2. As the figure shows, these cells, neurons, have specialised into many many types. They serve different functions, include different proteins and markers, and can be classified in many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

The brain: in numbers: neurons



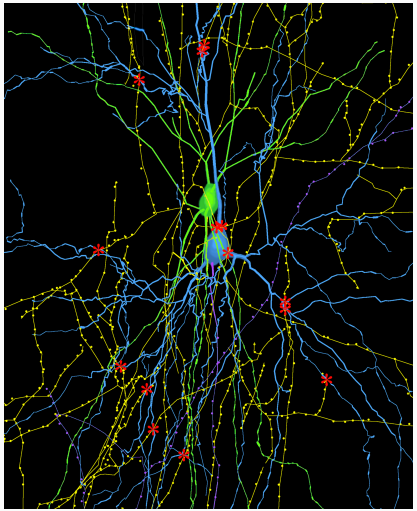
- 86B neurons[1].

[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



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.

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

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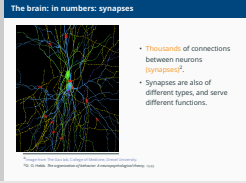
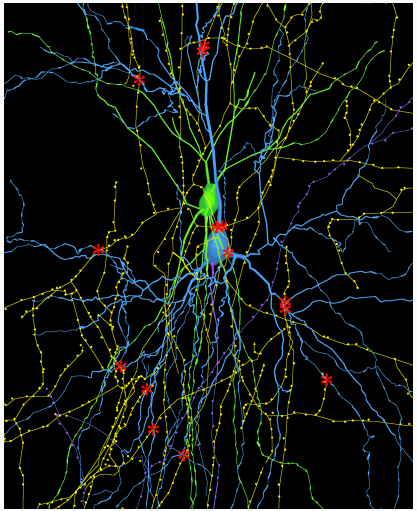


1. Each neuron connects with thousands of other neurons, forming a massive network.
2. So, the brain can be thought of as a massively parallel processor.

The brain: in numbers: synapses



- Thousands of connections between neurons (synapses)[2].
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- Synapses underlie learning[3].

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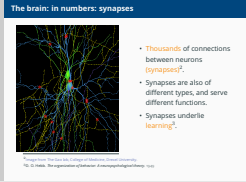

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- how it is structured (anatomy),
- about its chemicals (pharmacology, biochemistry),
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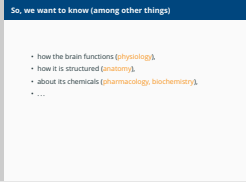

So, we want to know (among other things)

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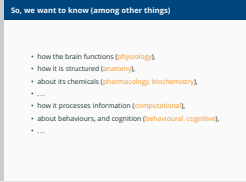
- how it processes information (computational),
- about behaviours, and cognition (behavioural, cognitive),
- ...



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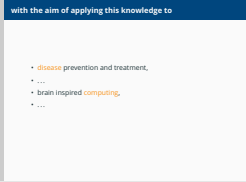

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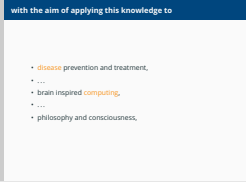
- philosophy and consciousness,



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How: research pipeline

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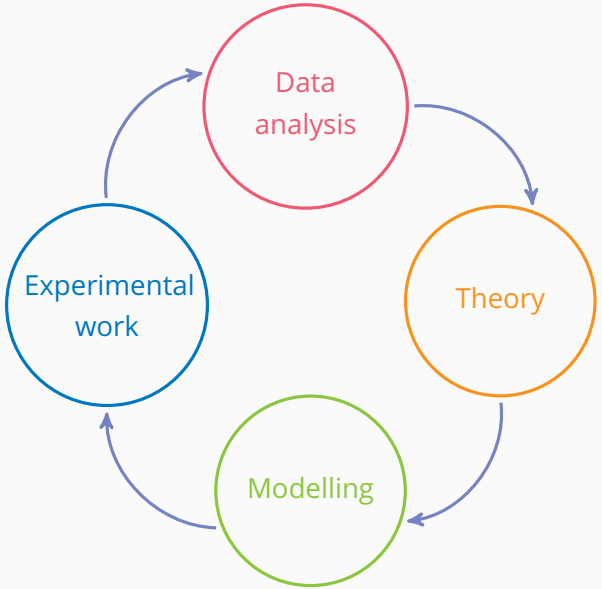
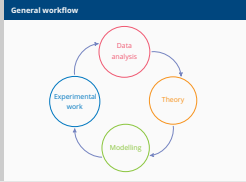
General workflow





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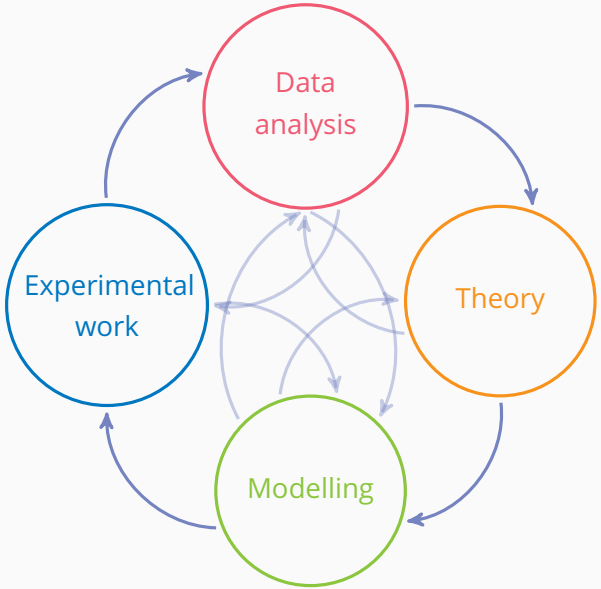

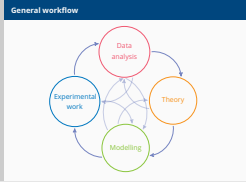

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Tools of the trade

Experimental:

- EEG, ECoG, intracellular and extracellular single and multi neuron recording,
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Theory and modelling:

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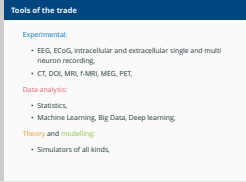

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Tools of the trade: II

Tools for the dissemination of knowledge[4]:

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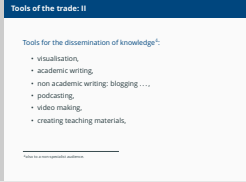

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Collaborative tools and utilities.

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

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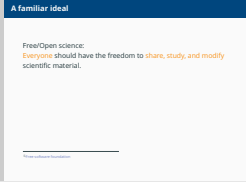

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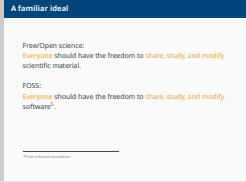

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Free/Open Science implicitly includes, and relies heavily on FOSS.

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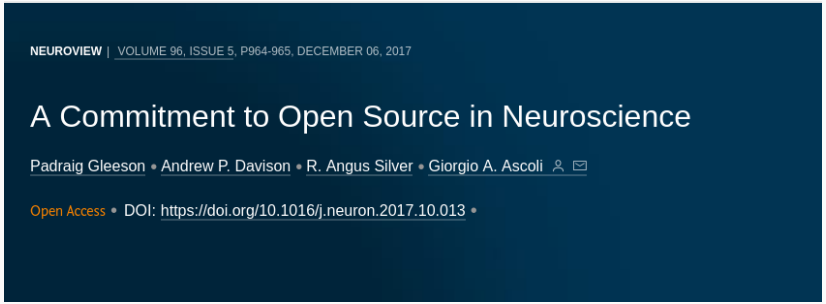
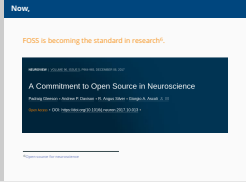
Now,

FOSS is becoming the standard in research[6].



[6] Open source for neuroscience



What can we, Fedora, do to help?

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(Anecdotal) notes on users of research software

- waste time and effort installing (and reinstalling) their software stacks,

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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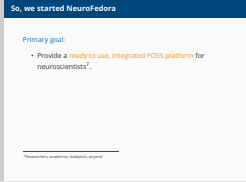
So, we started NeuroFedora

Primary goal:

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

[7] Researchers, academics, hobbyists, anyone!



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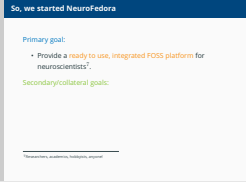

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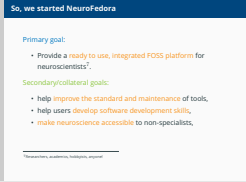

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- make Fedora the go-to distribution for neuroscience.

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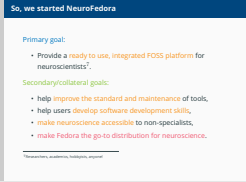

In essence,

NeuroFedora is:

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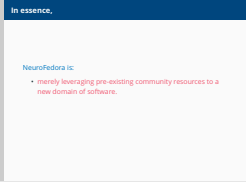

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NeuroFedora is:

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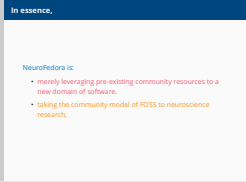
- taking the community model of FOSS to neuroscience research,



NeuroFedora: current metrics

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[9] src.fedoraproject.org: Neuro-SIG
[10] Pagure.io: Neuro-SIG: issues
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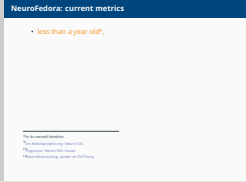

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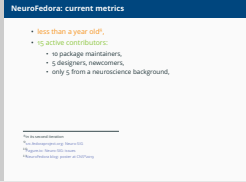

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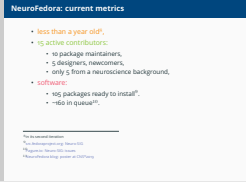

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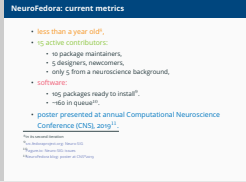

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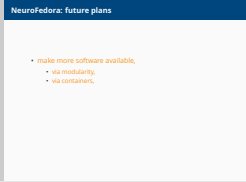

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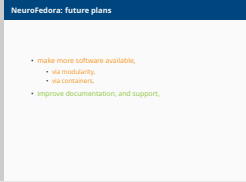

NeuroFedora: future plans

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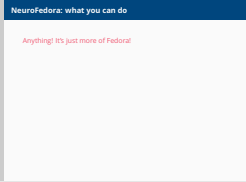
- improve documentation, and support,
- increase community,
  - convert research user base into FOSS contributors,
  - convert FOSS contributor base into users,

NeuroFedora: what you can do

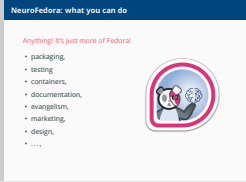
Anything! It's just more of Fedora!



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
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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

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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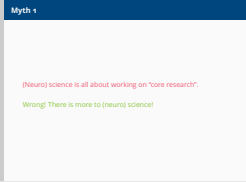
Wrong! There is more to (neuro) science!



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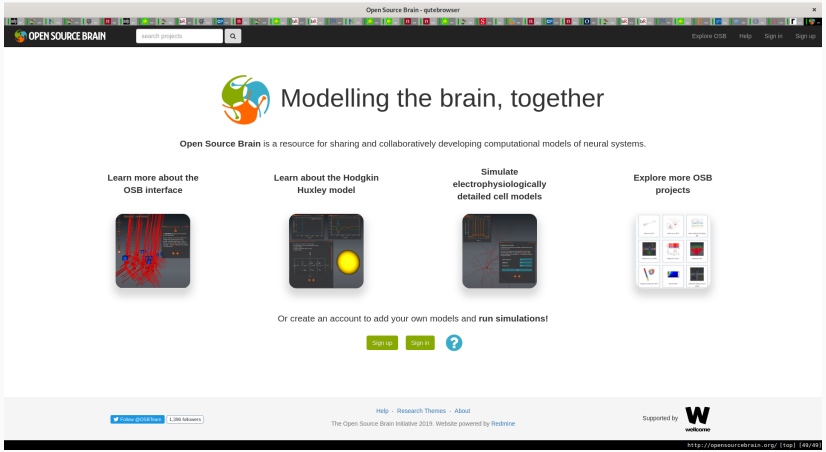
Myth buster example: Open Source Brain



[12] opensourcebrain.org

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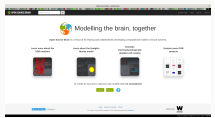

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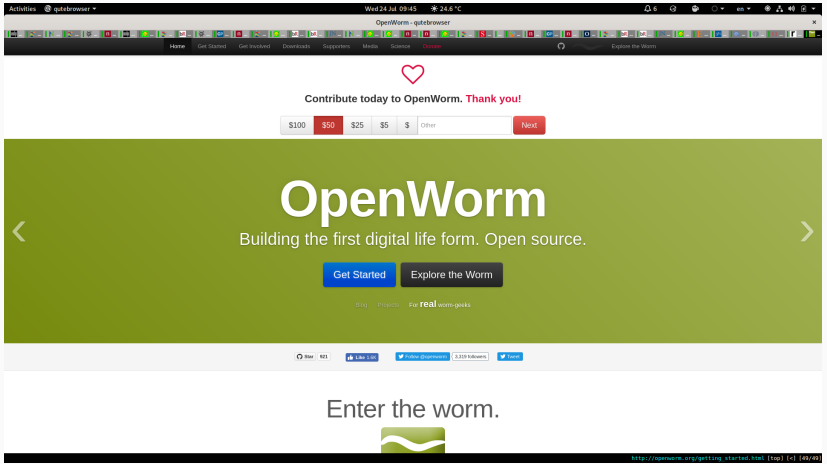
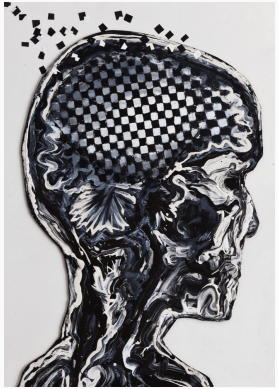


[13] openworm.org

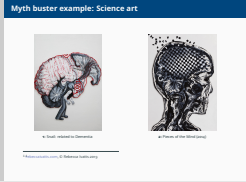
Myth buster example: Science art

1: Snail: related to Dementia



2: Pieces of the Mind (2014)

[14] rebeccaivatts.com, © Rebecca Ivatts 2019



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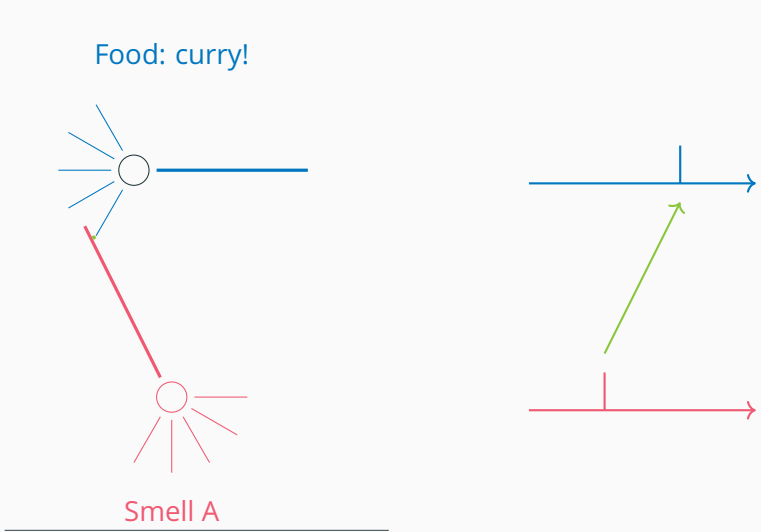
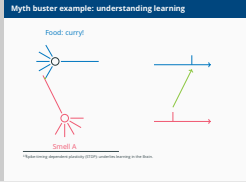


[1] Spike-timing dependent plasticity (STDP): underlies learning in the Brain.



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!
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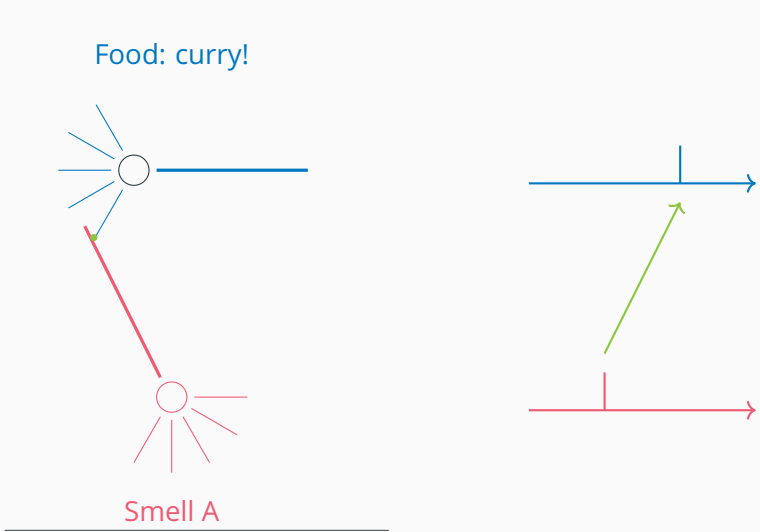

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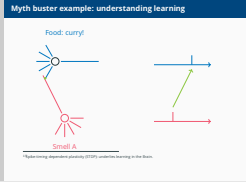

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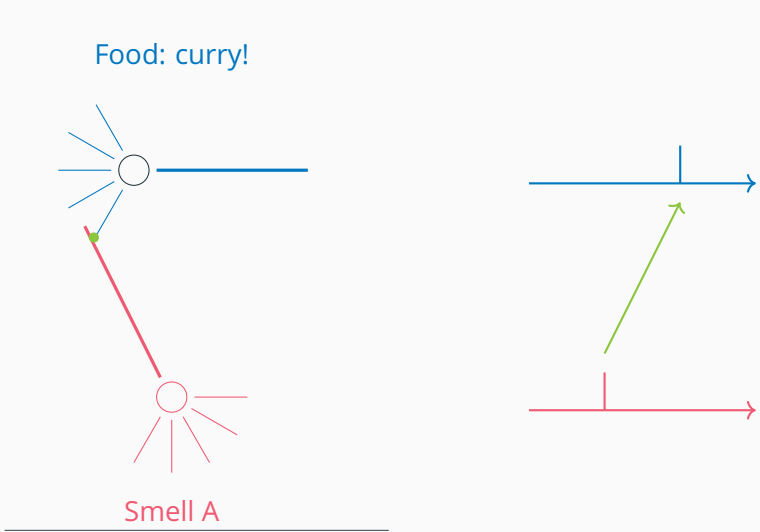

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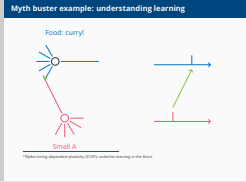

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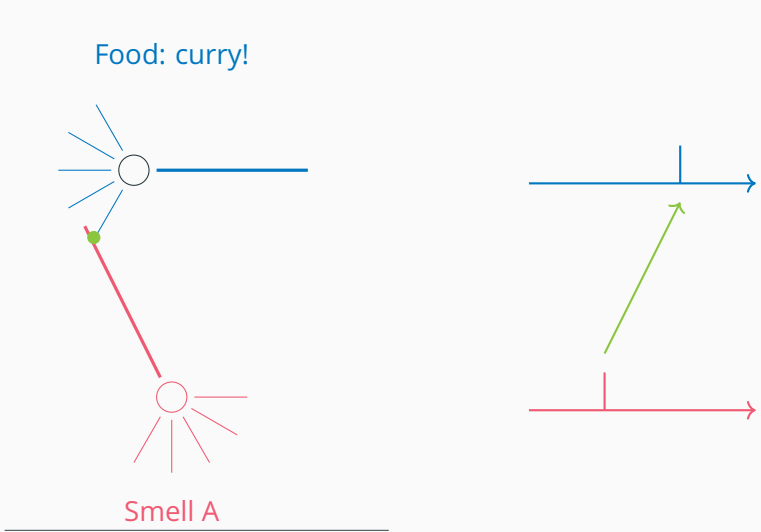

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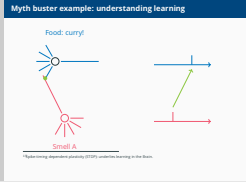

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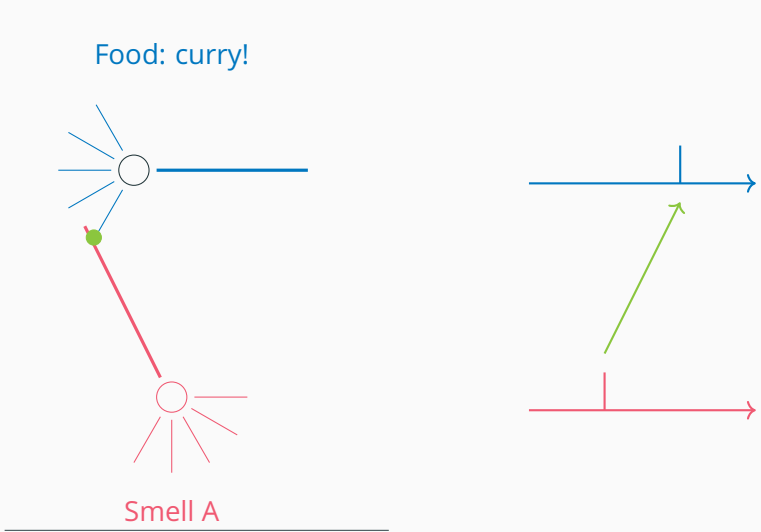

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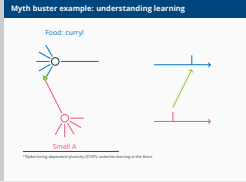

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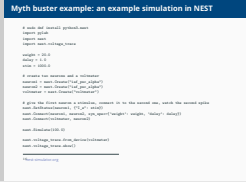
Myth buster example: an example simulation in NEST

```
# 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()
```

[16] nest-simulator.org



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.