Beyond open-source software: open data, open anatomy, and open hardware in neuroscience

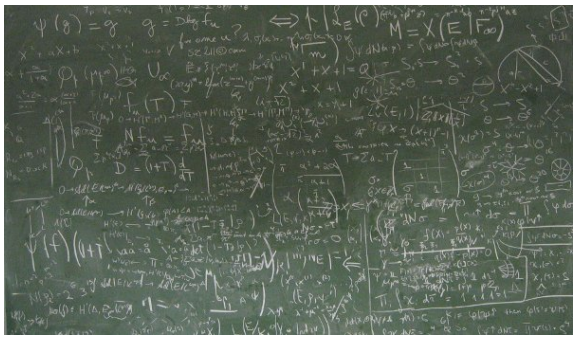
Arne

Gatsby Unit, UCL

Tea talk
November 23, 2015

A common problem in (computational) neuroscience

Some (neural) model



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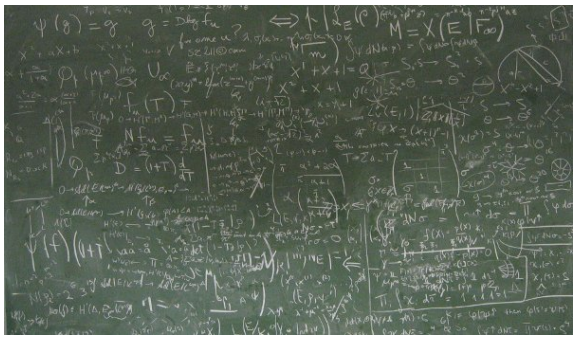
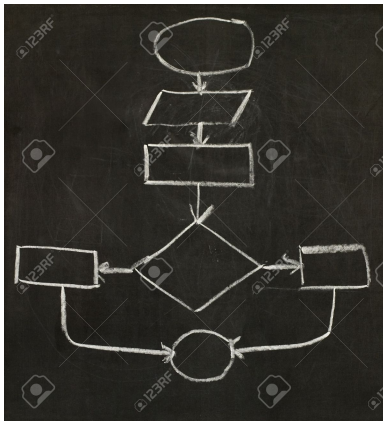


$\longleftrightarrow$

Awesome algorithm



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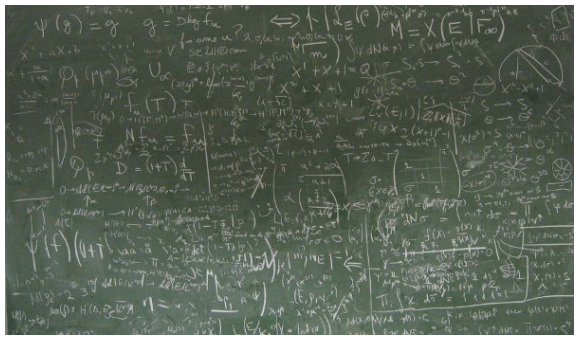

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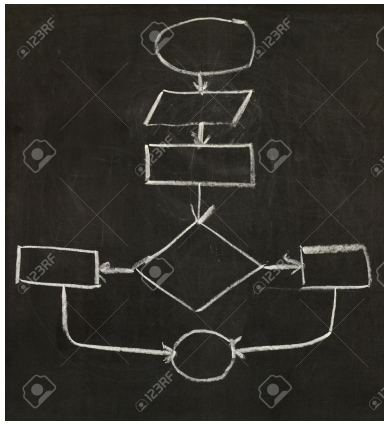

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Ideal world

- Experimentalists do your experiment in a couple of days/weeks

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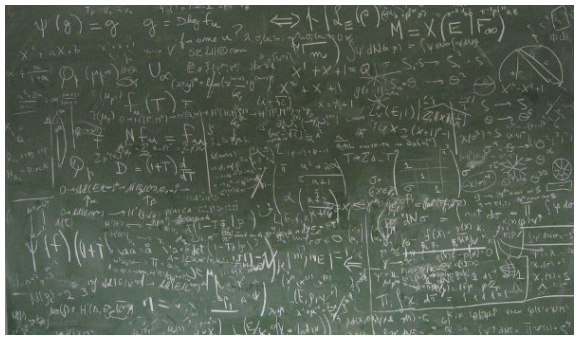

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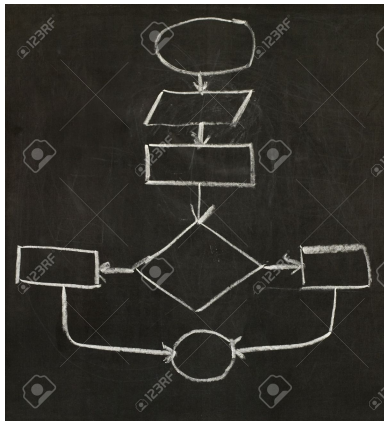

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2. Hardware/parts expensive or not available

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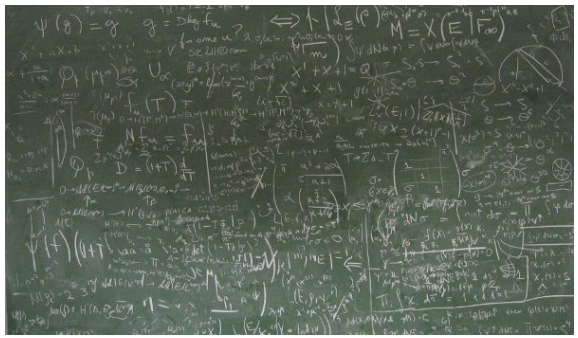

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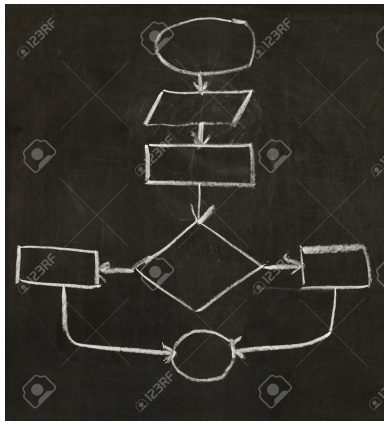

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- Usually already published data
- Reproduce results
- Reanalyze data
- Develop new techniques

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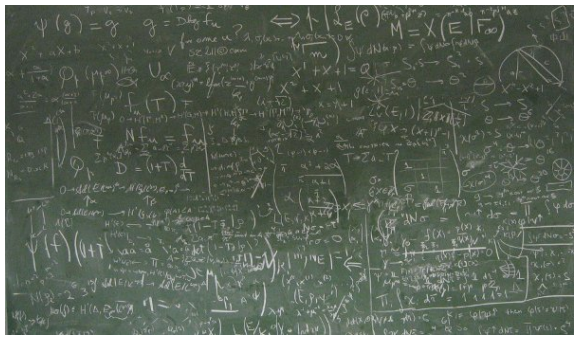

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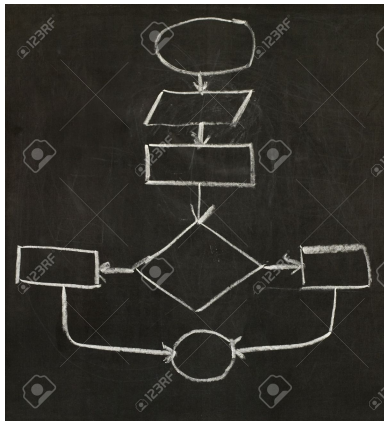

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Ideal world

- Experimentalists do your experiment in a couple of days/weeks

Open hardware

- Build your own hardware using existing designs
- Workshop, 3D printing, circuithub etc.
- Adapt design, don't design from scratch

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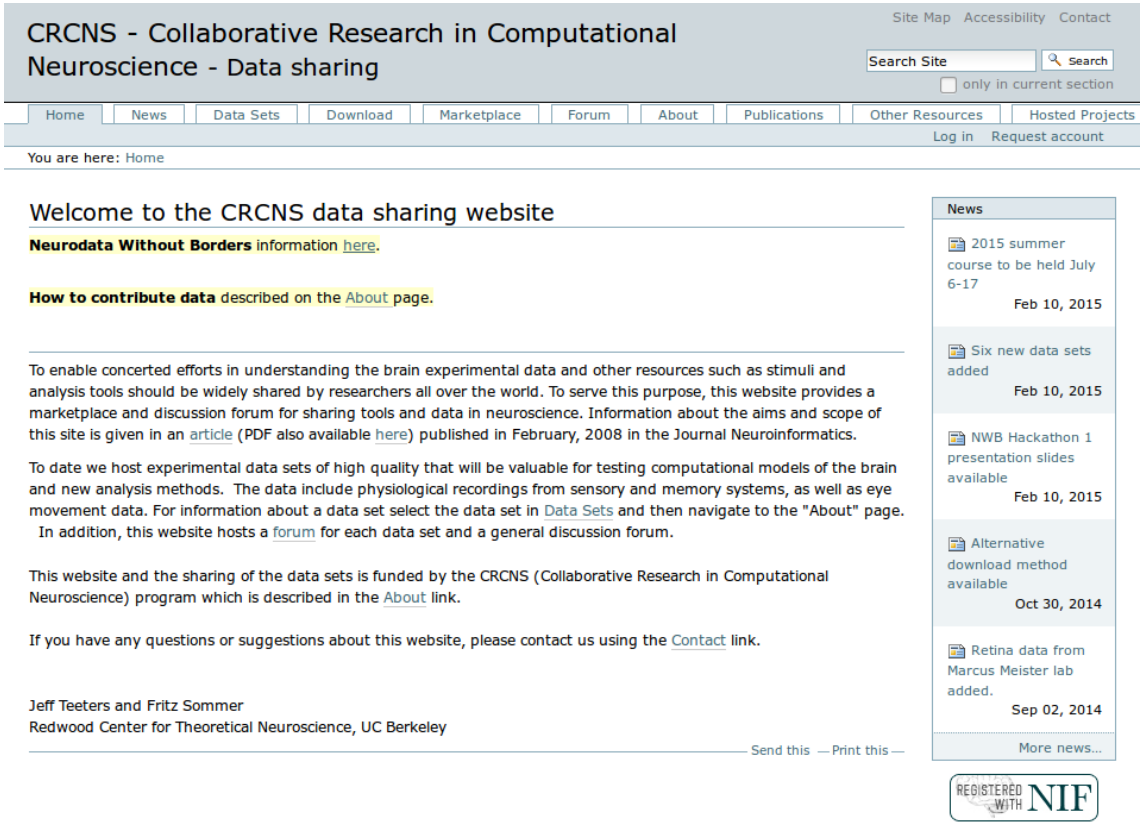
Example: Collaborative Research in Computational Neuroscience (CRCNS)



- `http://crcns.org`
- Joint program of NSF and NIH (since 2002)
- Emphasis on data quality

Open data

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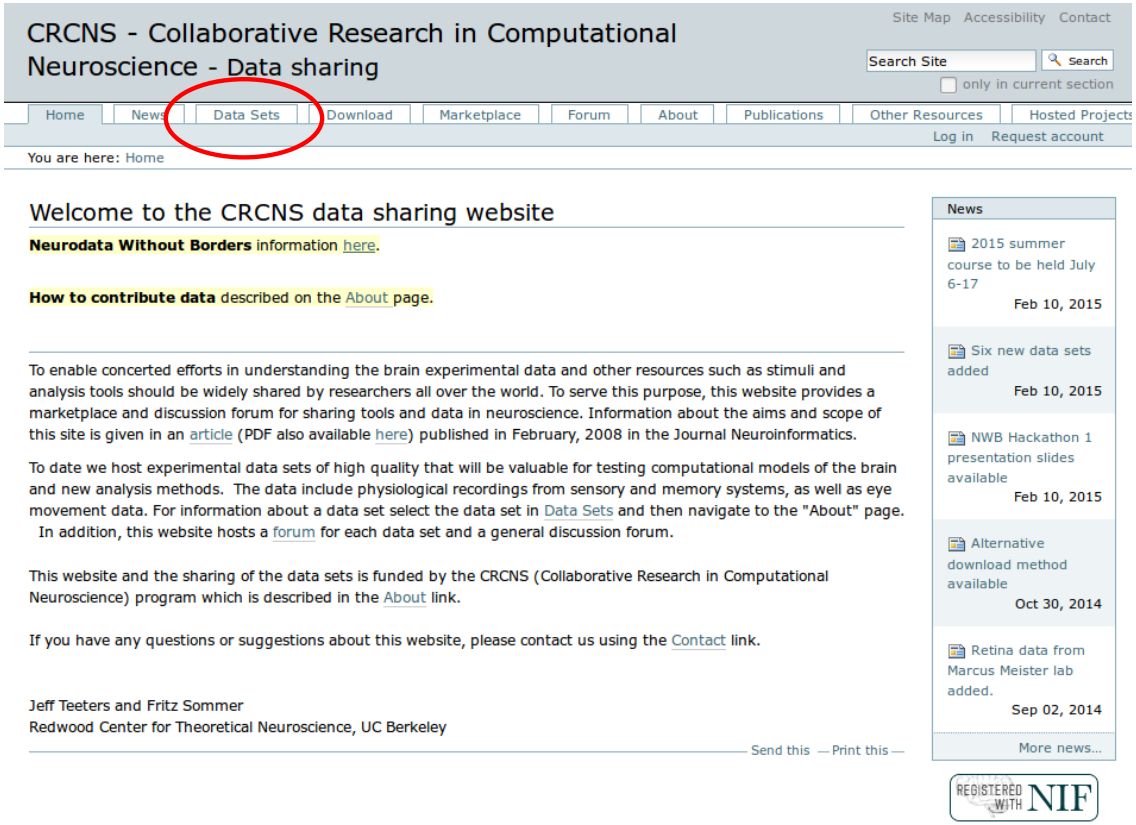

CRCNS - Collaborative Research in Computational Neuroscience - Data sharing

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only in current section

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Welcome to the CRCNS data sharing website

Neurodata Without Borders information here.

How to contribute data described on the About page.

To enable concerted efforts in understanding the brain experimental data and other resources such as stimuli and analysis tools should be widely shared by researchers all over the world. To serve this purpose, this website provides a marketplace and discussion forum for sharing tools and data in neuroscience. Information about the aims and scope of this site is given in an article (PDF also available here) published in February, 2008 in the Journal Neuroinformatics.

To date we host experimental data sets of high quality that will be valuable for testing computational models of the brain and new analysis methods. The data include physiological recordings from sensory and memory systems, as well as eye movement data. For information about a data set select the data set in Data Sets and then navigate to the "About" page. In addition, this website hosts a forum for each data set and a general discussion forum.

This website and the sharing of the data sets is funded by the CRCNS (Collaborative Research in Computational Neuroscience) program which is described in the About link.

If you have any questions or suggestions about this website, please contact us using the Contact link.

Jeff Teeters and Fritz Sommer
Redwood Center for Theoretical Neuroscience, UC Berkeley

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News

2015 summer course to be held July 6-17
Feb 10, 2015

Six new data sets added
Feb 10, 2015

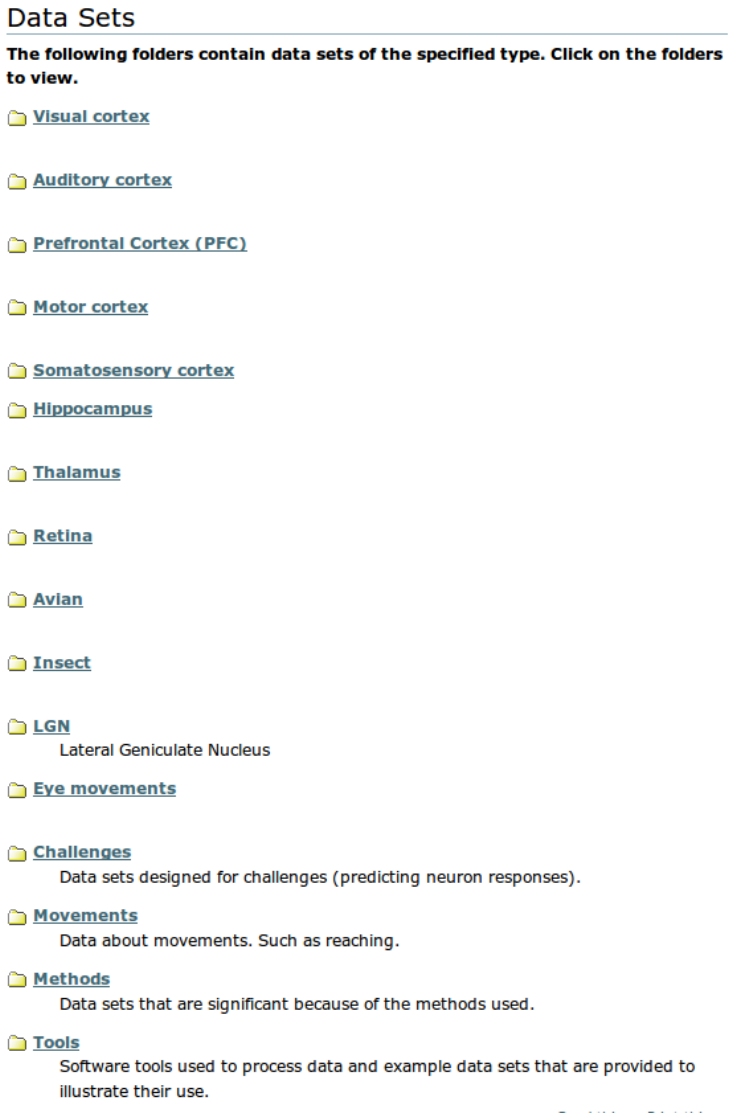
NWB Hackathon 1 presentation slides available
Feb 10, 2015

Alternative download method available
Oct 30, 2014

Retina data from Marcus Meister lab added.
Sep 02, 2014

More news...

REGISTERED WITH NIF



Data Sets

The following folders contain data sets of the specified type. Click on the folders to view.

- Visual cortex
- Auditory cortex
- Prefrontal Cortex (PFC)
- Motor cortex
- Somatosensory cortex
- Hippocampus
- Thalamus
- Retina
- Avian
- Insect
- LGN
  Lateral Geniculate Nucleus
- Eye movements
- Challenges
  Data sets designed for challenges (predicting neuron responses).
- Movements
  Data about movements. Such as reaching.
- Methods
  Data sets that are significant because of the methods used.
- Tools
  Software tools used to process data and example data sets that are provided to illustrate their use.

- `http://crcns.org`
- Joint program of NSF and NIH (since 2002)
- Emphasis on data quality

Examples

Visual cortex

pvc-1
Single- and multi-unit recordings from primary visual cortex. Contributed by Dario Ringach lab, UCLA.

pvc-2
Extracellular recording from cells in cat primary visual cortex (data from Yang Dan Lab at UC-Berkeley).

pvc-3
Multi-neuron recordings in primary visual cortex. Contributed by Tim Blanche, UC Berkeley.

pvc-4
Single electrode recordings from primary visual cortex. Contributed by Jack Gallant Lab, UC Berkeley.

pvc-5
Multi-electrode recordings of ongoing activity and responses to parametric stimuli in macaque V1. Contributed by Chou Hung lab, Georgetown University

pvc-6
In vitro whole-cell patch clamp recordings from visual cortex neurons in the adult mouse. Contributed by the Allen Institute for Brain Sciences.

pvc-7
In vivo calcium imaging of layer 4 cells in the mouse using sinusoidal grating stimuli. Contributed by the Allen Institute for Brain Sciences.

v2-1
Extracellular recordings from area V2 of awake behaving rhesus monkey. Contributed by Jack Gallant lab, UC Berkeley.

vim-1
fMRI of human visual areas in response to natural images. Contributed by Jack Gallant lab, UC Berkeley.

vim-2
Gallant Lab Natural Movie 4T fMRI Data. Contributed by Jack Gallant lab, UC Berkeley.

vim-3
fMRI responses of human visual cortex (v1, v2, v3) to natural image patches obtained from above and below the centre of gaze of an observer freely-navigating an outdoor environment. Contributed by Damien J. Mannion, UNSW Australia

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Hippocampus

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Simultaneous intracellular and extracellular recordings from hippocampus region CA1 of anesthetized rats. Contributed by Gyorgy Buzsáki lab, New York University.

hc-2
Multi-unit recordings from the rat hippocampus made during open field foraging (contributed by Gyorgy Buzsáki lab, New York University).

hc-3
Multiple single unit recordings from different rat hippocampal and entorhinal regions while the animals were performing multiple behavioral tasks. Contributed by Gyorgy Buzsáki lab, New York University.

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Extracellular recordings from muiti-site silicon probes used for clustering of neuron responses in rat hippocampal and entorhinal regions. Contains additional data (including raw data) used for spike sorting of some neuron responses provided in the hc-3 data set. Contributed by the lab of Gyorgy Buzsáki.

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Simultaneous extracellular recordings from left and right hippocampal areas CA1 and right entorhinal cortex from a rat performing a left / right alternation task and other behaviors. Contributed by Eva Pastalkova. Recordings made while in the lab of Gyorgy Buzsáki.

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Prefrontal Cortex (PFC)

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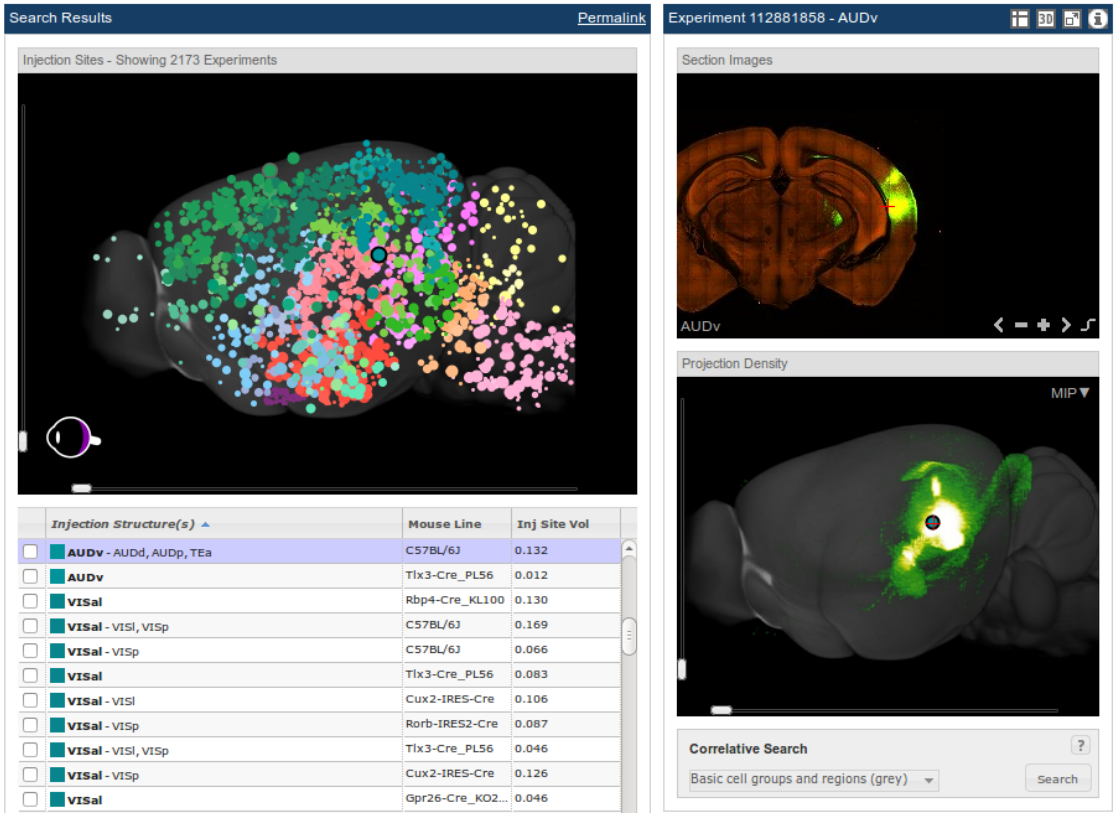
Spiking responses of neurons in rodent prefrontal cortex and auditory cortex during a novel stimulus selection task. Contributed by Chris Rodgers. Data recorded in the lab of Mike DeWeese at UC Berkeley.

pfc-2
Simultaneous electrophysiological recordings of ensembles of isolated neurons in rat medial prefrontal cortex and intermediate CA1 area of the hippocampus during a working memory task. Recorded by Shigeyoshi Fujisawa in the lab of György Buzsáki.

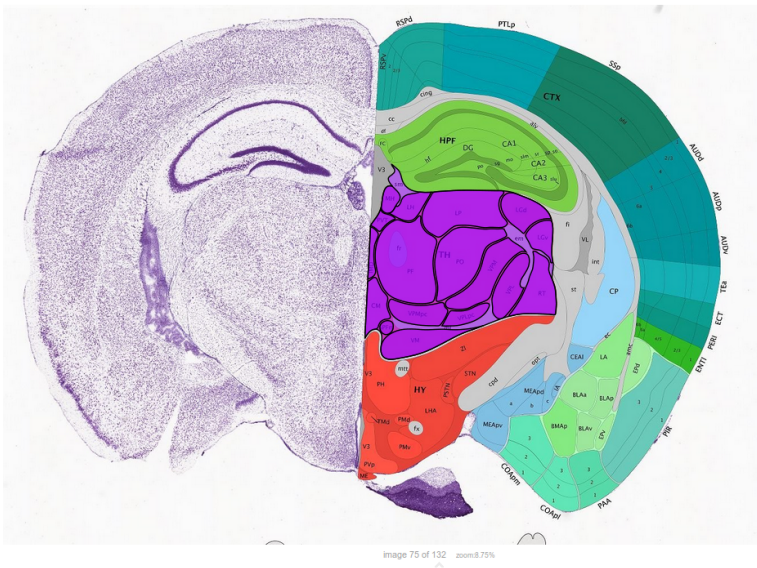
Open anatomy

Example: Allen Brain Atlas

Connectivity



Reference atlas

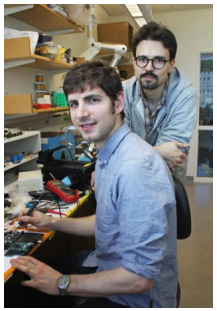


Allen Institute for Brain Science

`http://www.brain-map.org`

Open hardware

Example: open-ephys (`http://www.open-ephys.org`)



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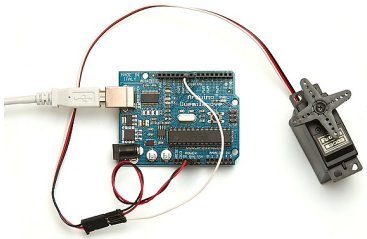

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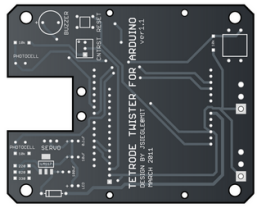
PCB printing



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3D printing

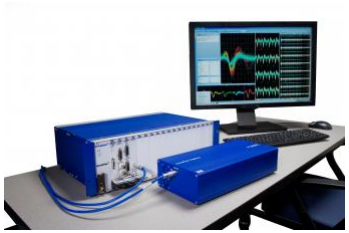
=

- **Open-source hardware:** Arduino, Beaglebone, Raspberry Pi, ...
- **PCB printing:** many companies specialized on small batch manufacturing; UCL CS FabSpace!
- **3D printing:** already available in many labs; UCL Institute of Making and UCL CS FabSpace

Open hardware

Example: open-ephys (`http://www.open-ephys.org`)

20k – 50k GBP for 512 channels



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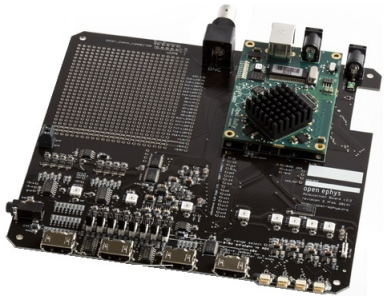

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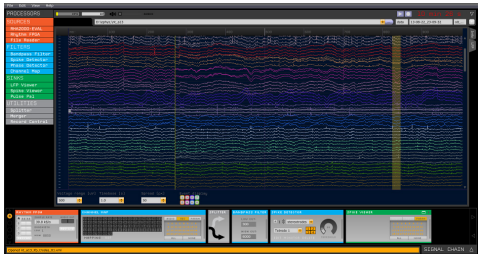

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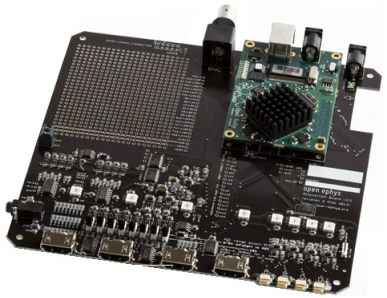

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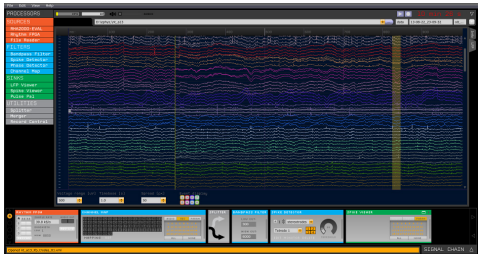

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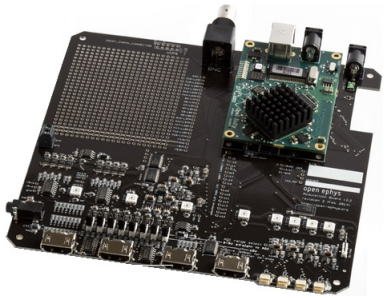
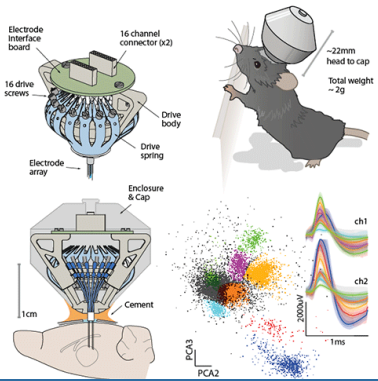
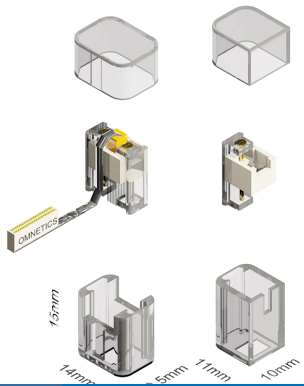


Tetrode drives (Voigts et al. 2014)



Microelectrode arrays (Englitz et al. 2011)



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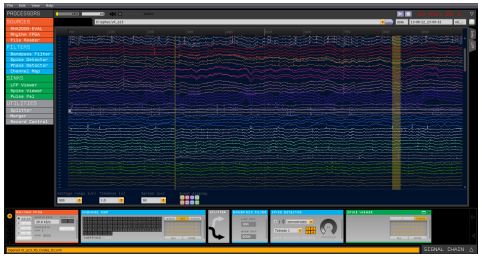

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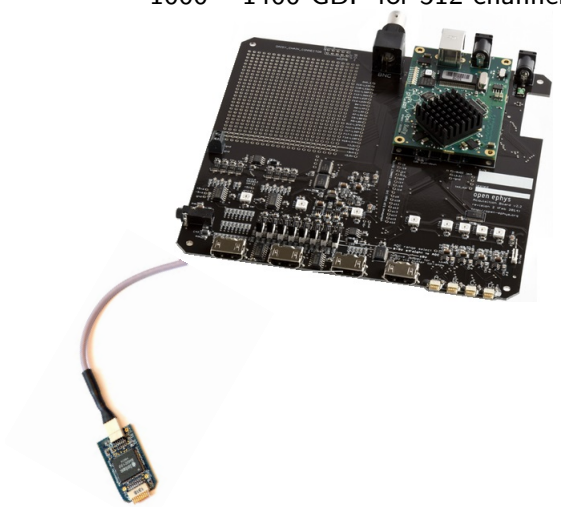

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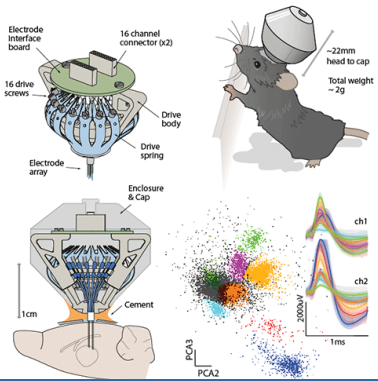

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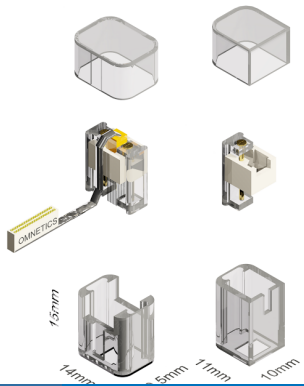

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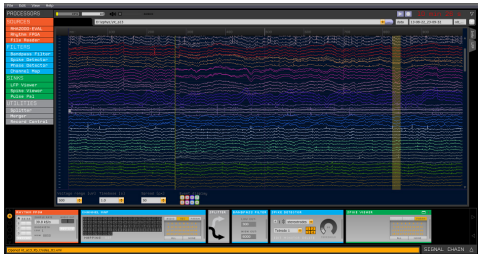

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        {
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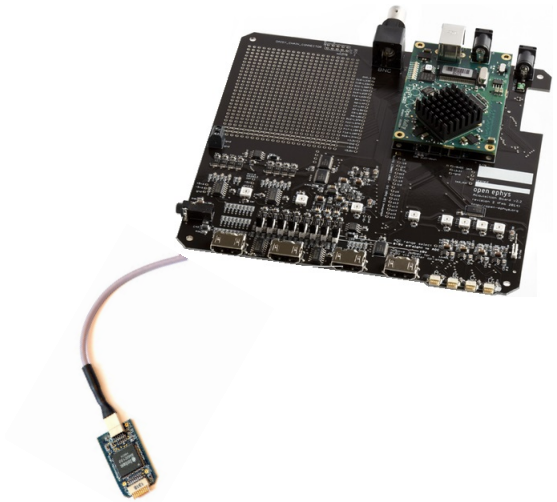
            filters[n]->process(nSamples, &ptr);
        }
    }

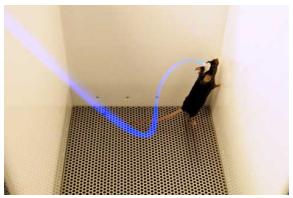
}
```

20k – 50k GBP for 512 channels

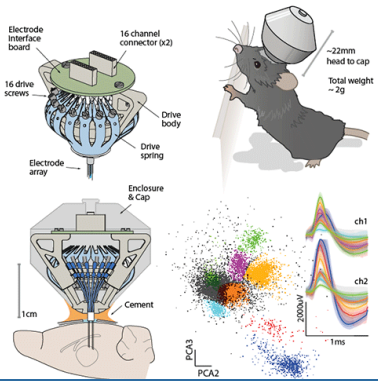
1000 – 1400 GBP for 512 channels



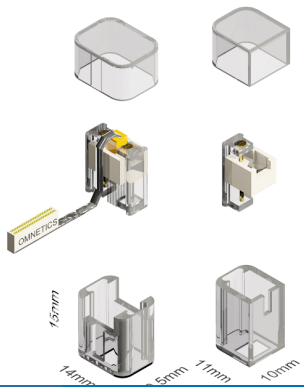
LED driver (P. Newman)



Tetrode drives (Voigts et al. 2014)

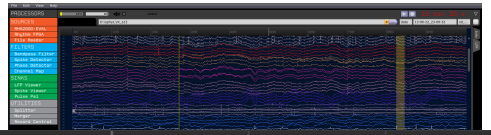


Microelectrode arrays (Englitz et al. 2011)

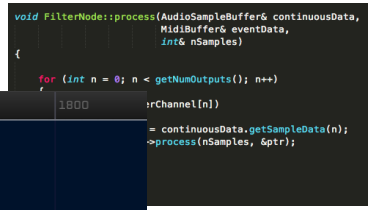


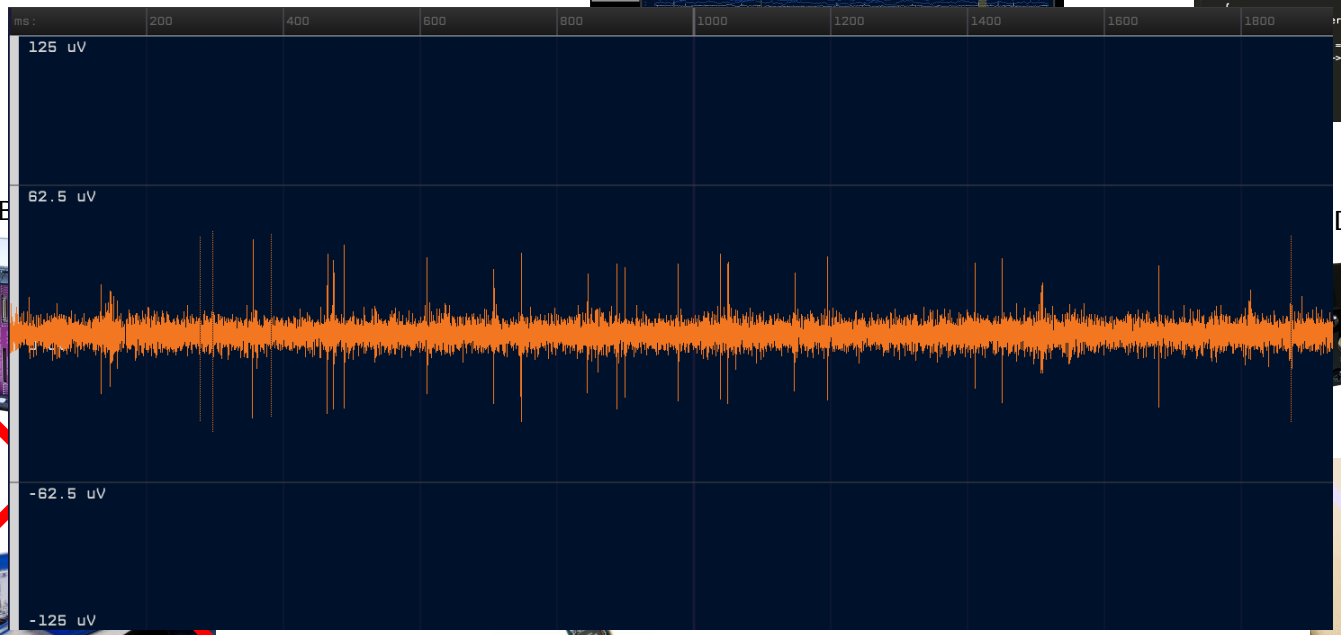
Open hardware

Example: open-ephys (`http://www.open-ephys.org`)



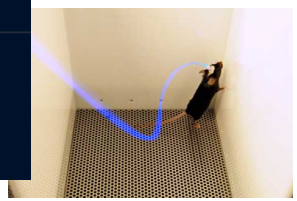
Designed to be extended with Plugins



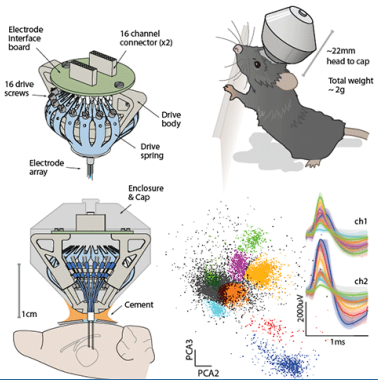


20k – 50k GE

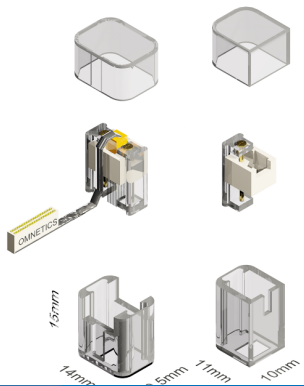
D driver (P. Newman)



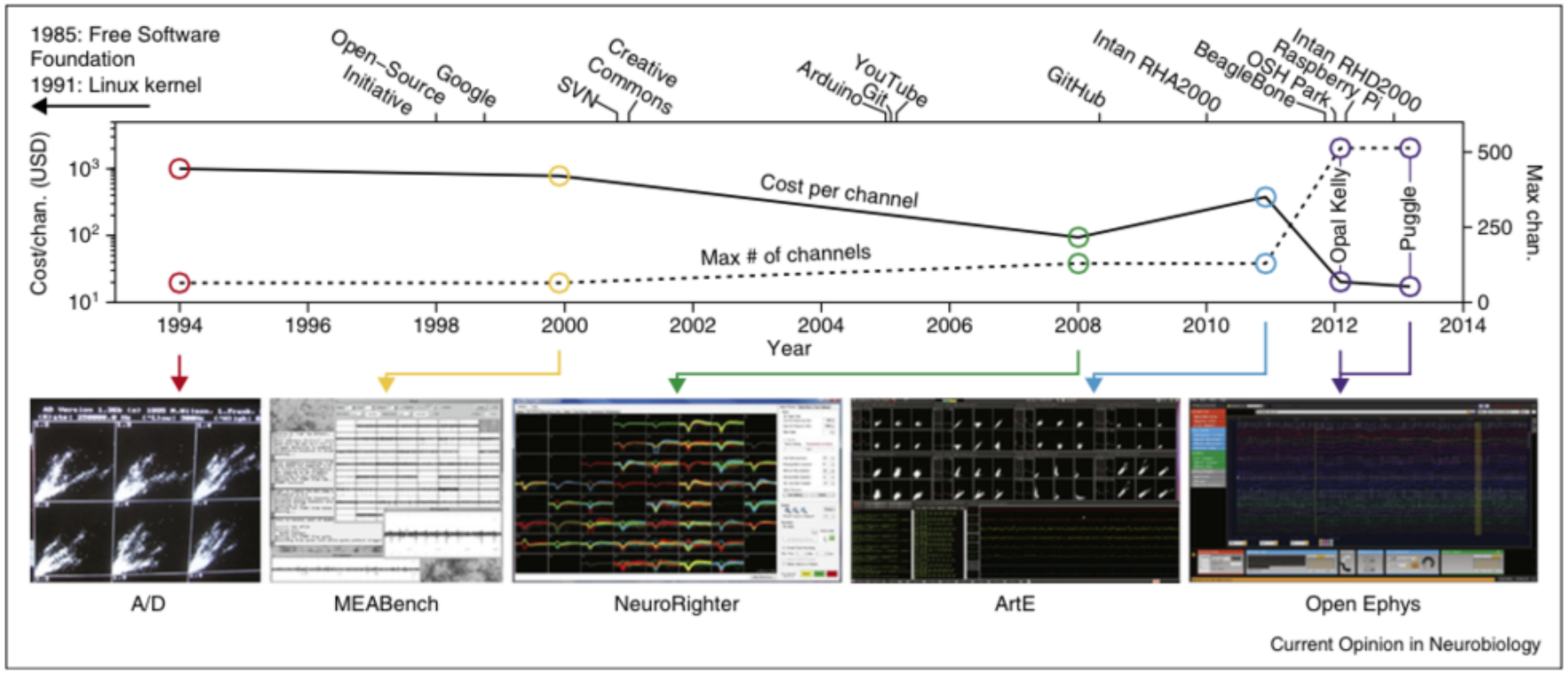
Tetrode drives (Voigts et al. 2014)



Microelectrode arrays (Englitz et al. 2011)



Cost vs # channels



Voigts et al. 2015

Some things to remember ...

- There is an increasing number of freely available (high-quality) data sets
- Reusing data is one of the principles of the 3Rs in animal research – Replacement, Reduction and Refinement
- Open-source approaches to hardware for large-scale electrophysiology (and also initial attempts for optical methods)
- Collaborative development instead of many almost identical in-house solutions
- It has only just started ...