Improving Spike Sorting

(untangling the brain's cables)

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What is Spike sorting?

According to Wikipedia:

> *Spike sorting refers to the process of assigning spikes to different neurons.*

Spike sorting's applications

- Prosthetics.
  - Missing limbs.
  - Locked-in syndrome.
  - Remote presence.
- Disease diagnosis.
  - Detect abnormal firing patterns.
- Research.
  - Pinpoint certain neurons as triggers for some action.

In other words: **HUGE** impact!

What does the problem look like?

- (Multi-)Electrodes are inserted in live animals (in-vivo) or cultures of brain cells (in-vitro) during experiments

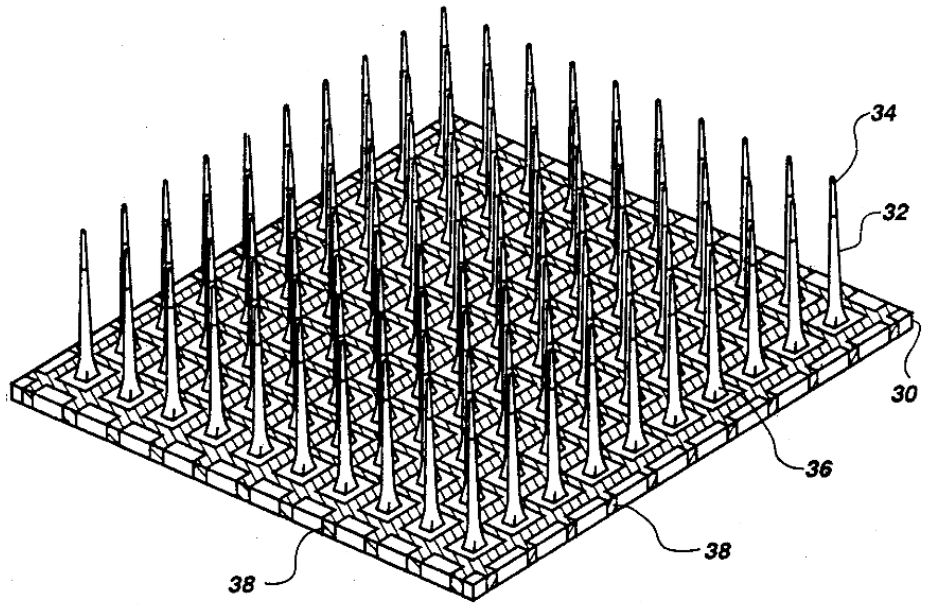

Figure: Electrode array (Source: `http://scholarpedia.org/`)

- Electrical readings are taken from the brain cells via the electrodes.

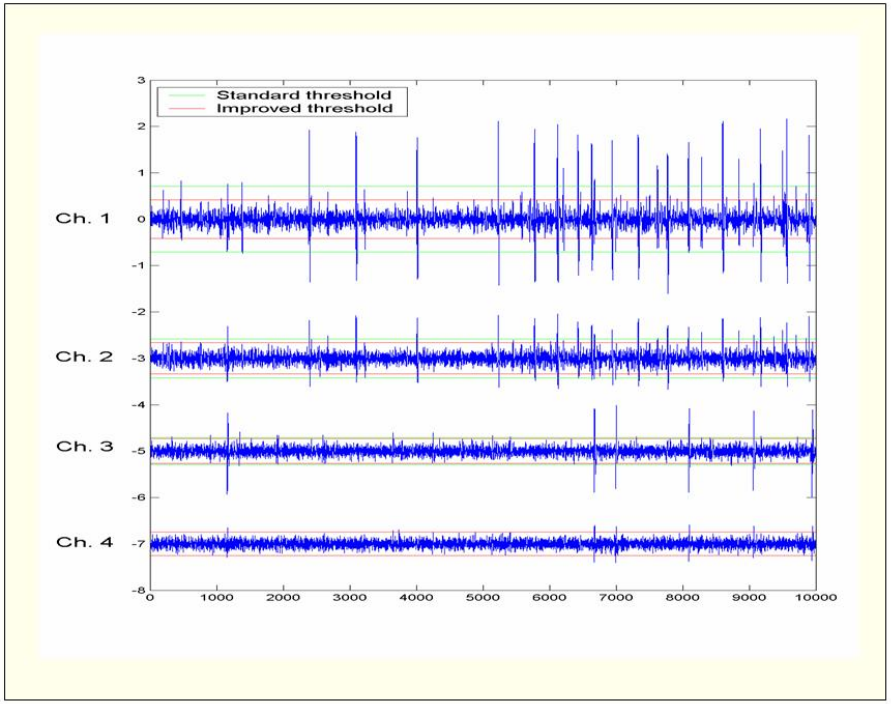

Figure: Electrode readings (Source: `http://scholarpedia.org/`)

- Some process is applied to the input signal(s) [$\Leftarrow$ spike sorting proper].

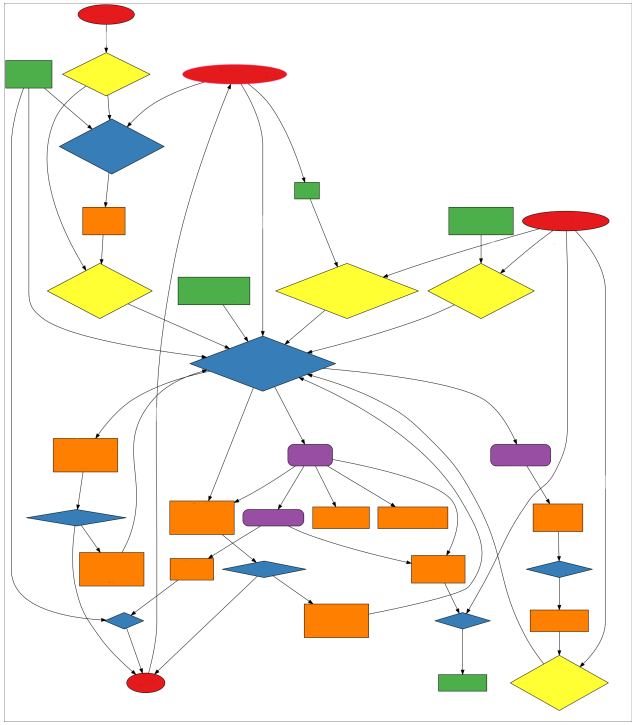

Figure: Preprocessing and sorting procedure(s) (Source: `http://wikimedia.org/`)

- ... And we identify what neuron caused which spike.

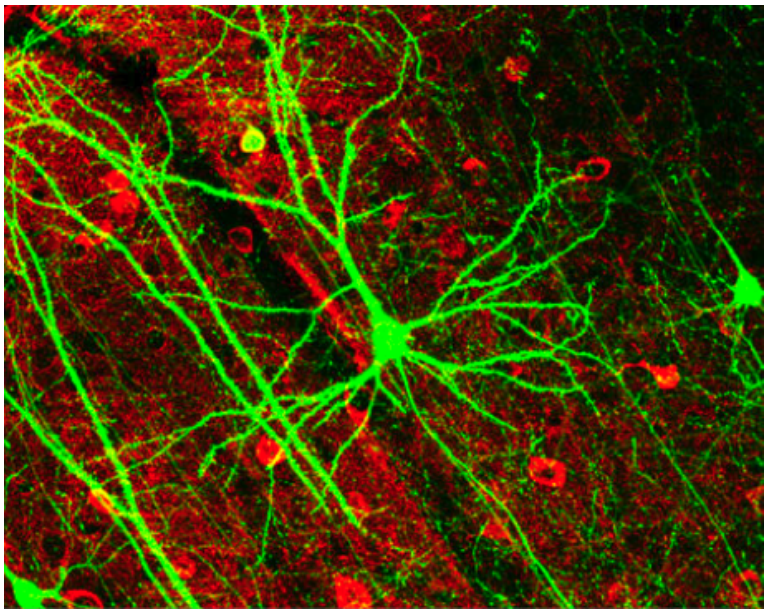

Figure: The culprit (Source: `http://wikimedia.org/`)

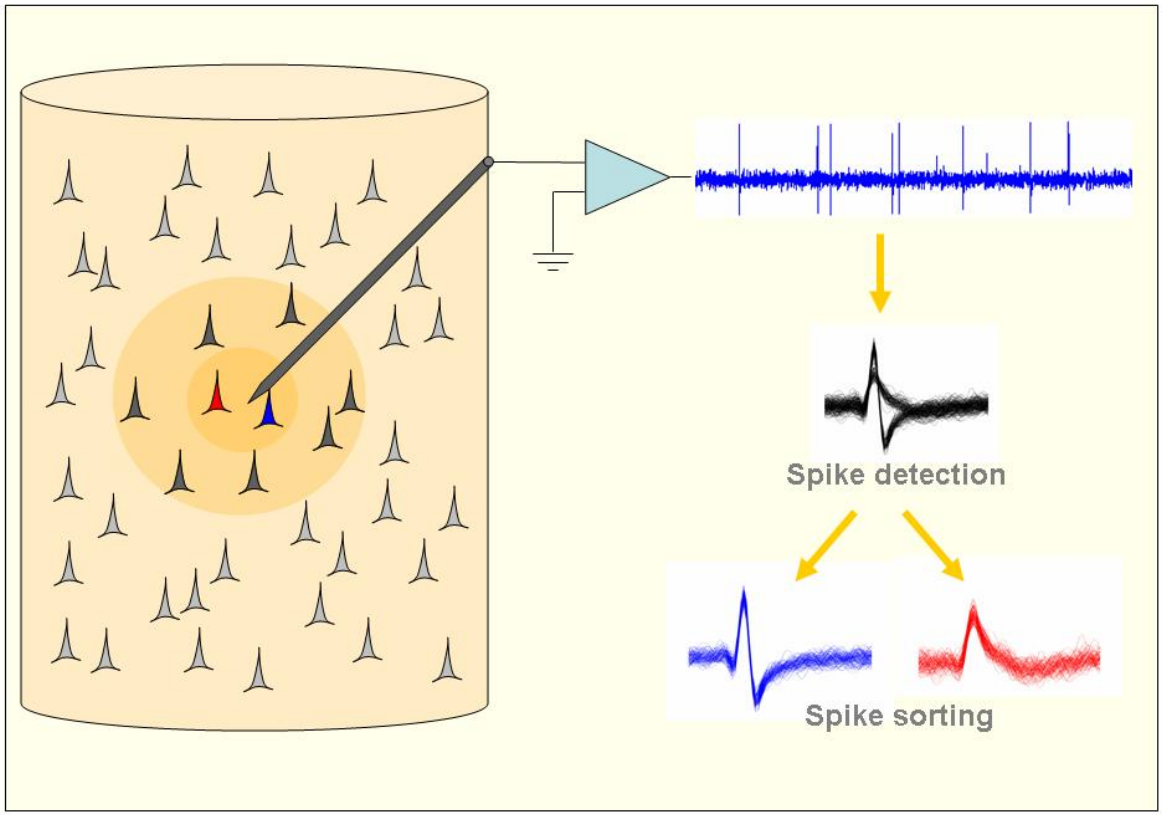

Figure: Spike sorting in a nutshell (Source: `http://scholarpedia.org/`)

Challenges

- Difficult to evaluate the methods' performance.
  - No ground truth in the in-vivo case.
- Spikes sometimes overlap.
- Some common assumptions do not always hold.
  - A neuron's spikes have all the same form.
  - All neurons produce different spike's forms.
  - The spikes' form is time-invariant.

- We're basically trying to identify the source of a signal by sticking a rod into a mess of cables.

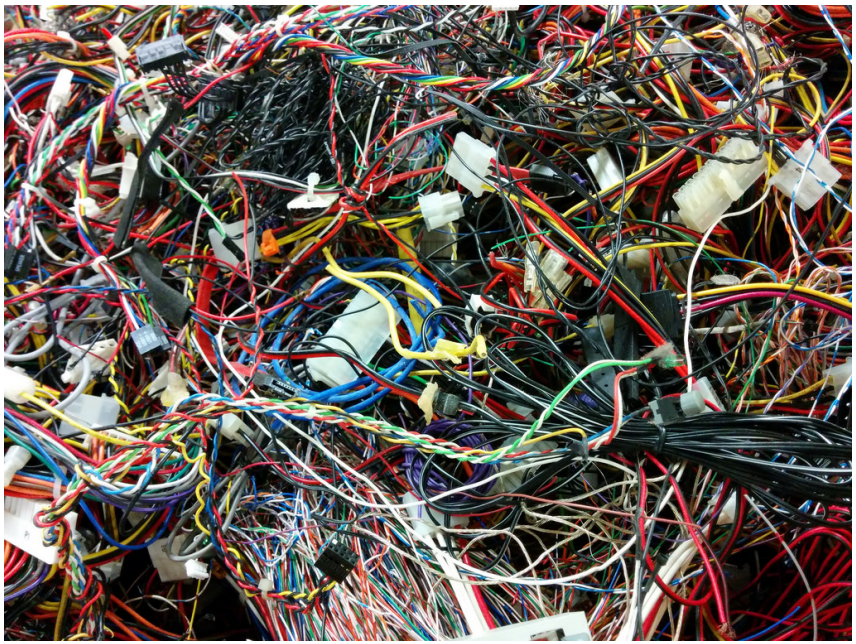

Figure: A methaphoric brain (Source: `https://www.flickr.com/photos/doctorow`)

Project's Objectives

The project aims to have a working spike sorting pipeline. The main tasks are:

- Research current state-of-the-art.
- Implement one or more likely candidates, e.g.:
  - Signal filters.
  - Probabilistic models.
  - Artificial neural networks.
- Evaluate performance using synthetic or in-vitro recordings.
- Write findings in a research paper.

END

THANK YOU!