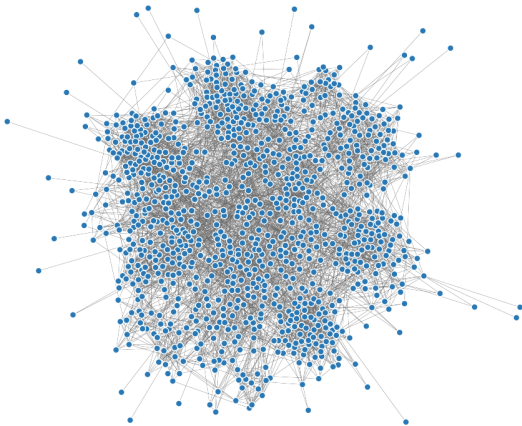


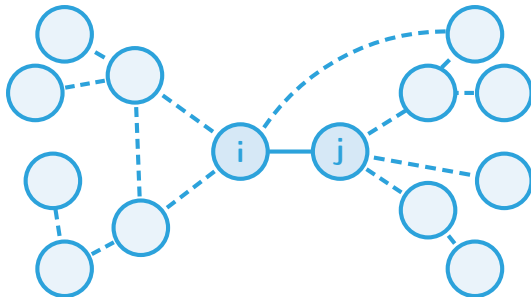
Simple connectome inference from partial correlation statistics in calcium imaging

Antonio Suter, Arnaud Joly, Vincent François-Lavet, Zixiao Aaron Qiu
Gilles Louppe, Damien Ernst and Pierre Geurts (aka The AAAGV Team).



Introduction

From time-series of the neuron activity, the **goal** is to **infer the directed connections between neurons**.



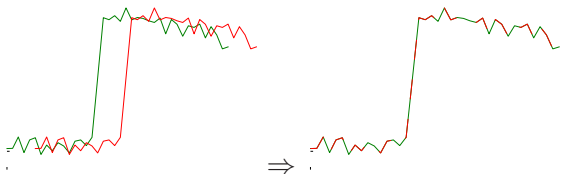
Introduction

But this problem is **difficult** because of...

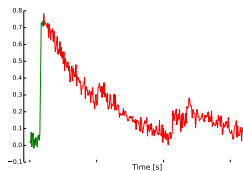
▶ **masking** effects



▶ **low** sampling rate



▶ **slow** decay of fluorescence.



How-to :

1. **Deal** with calcium fluorescence signals : [signal processing](#).
2. **Find** the network : the [inference method](#).
3. **Improve** the method : [averaging](#) and [tuning](#).

One step further :

- ▶ Improvement of each stage of our solution.
- ▶ Comparison with other methods.

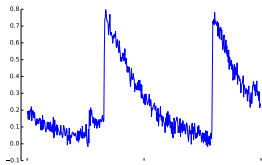
Even further :

- ▶ The “full method” in a nutshell.

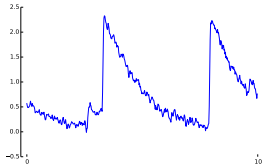
Signal processing

Signal processing

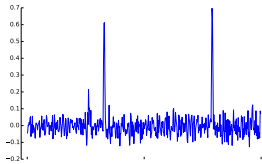
1. Applying a low-pass filter
2. Applying a high-pass filter
3. Applying a hard-threshold filter
4. Magnify the importance of spikes that occur in case of low global activity



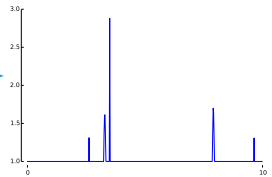
1



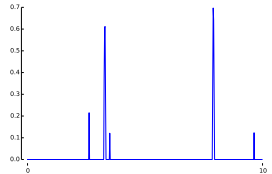
2



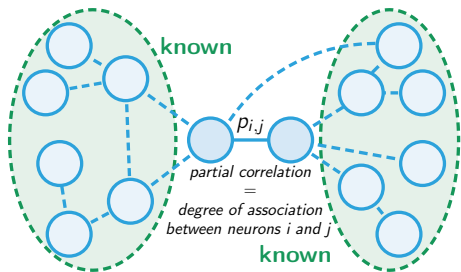
3



4



Connectome **inference** from **partial correlation statistics**



Partial correlation coefficient $p_{i,j}$
between neurons i and j defined by :

$$p_{i,j} = -\frac{\Sigma_{ij}^{-1}}{\sqrt{\Sigma_{ii}^{-1} \Sigma_{jj}^{-1}}},$$

Advantages and drawbacks :

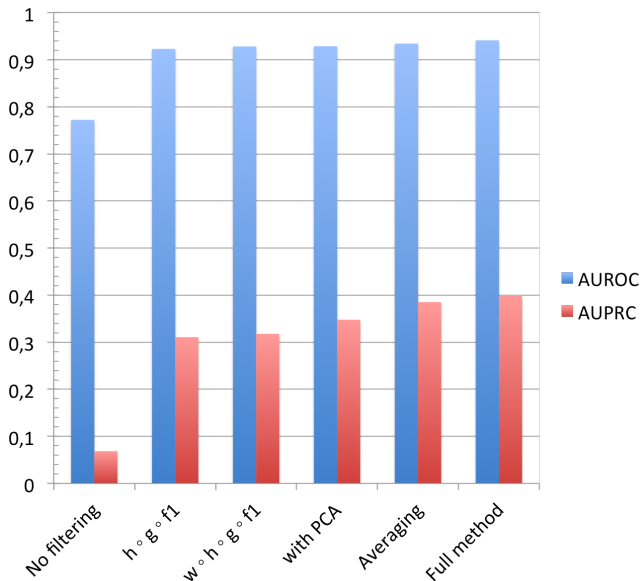
- ✓ Only direct associations
- ✓ Filter out spurious indirect effects
- ✓ Easy to compute (with lots of data)
- ✗ Edge orientation
- ✗ Sensitive to the value of parameters in the filtering process

Improvements

- ▶ **Approximation** for partial correlation statistics using only the 800 first principal components.
- ▶ **Averaged partial correlation statistics** over various values of the parameters
 - ✓ Improve robustness (over all networks)
 - ✓ Reduce variance of its prediction
 - ✓ Decrease the sensitivity to the filtering process

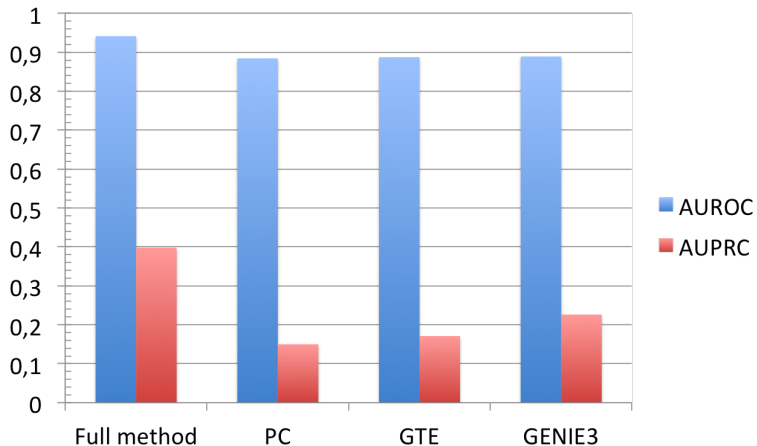
Each stage of our solution brings some improvement

Average scores on normal-1,2,3,4 datasets.



Comparison with other methods

Average scores on normal-1,2,3,4 datasets.



An optimized version to win the challenge : “Full method”

- ▶ A **tuned** signal processing,
- ▶ **Weighted** average of partial correlation statistics,
- ▶ **Prediction** of edge orientation.

For every details of our method...

The description of the method :

Sutera, A., Joly, A., François-Lavet, V., Qiu, Z. A., Louppe, G., Ernst, D., & Geurts, P. (2014). Simple connectome inference from partial correlation statistics in calcium imaging.

Code available at :

<https://github.com/asutera/kaggle-connectomics>