Spike Sorting with R and GGobi

Christophe Pouzat[1], Andrea Ridolfi[1] and Pascal Viot[2]

[1] Cerebral Physiology Laboratory, Paris V Univerity
[2] Theoretical Condensed Matter Physics Laboratory, Paris VI University

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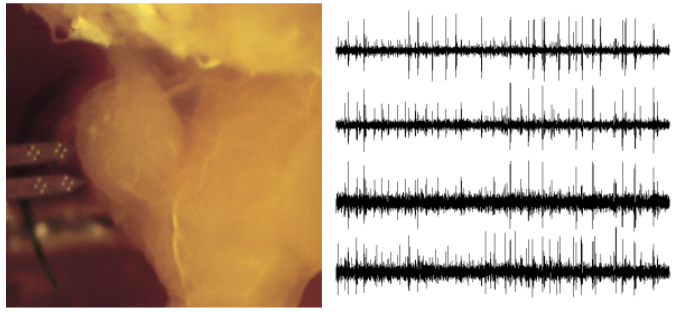
What is Spike Sorting?

Viewed from the 'outside' neuronal activity is seen as sequences of brief electrical impulses: the action potentials or spikes.



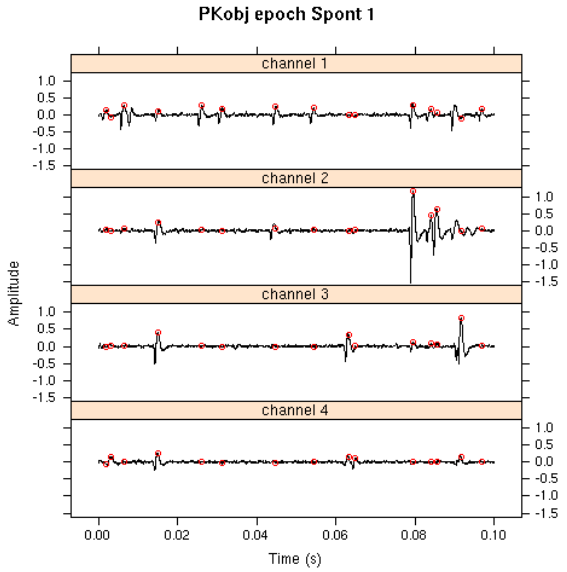
Example of recording from the first olfactory relay of an insect. Left, the brain and a recording probe with 16 electrodes (bright spots). The width of the shanks is 80 μm. Right, 1 sec of data from 4 electrodes.

What do Neurophysiologists Want?

After detecting and extracting putative spikes neurophysiologists seek answer to the following questions:

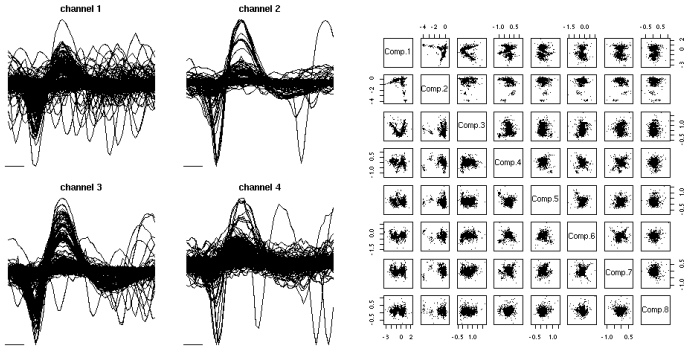
- How many neurons are recorded?
- What features of the spike waveforms can be used to classify or sort the spikes?
- Should spikes occurrence times be considered and if yes how?
- Can answers to the above questions be brought automatically and if yes with what error rates?

We Start With Spike Detection



Example of spike detection.

After Spike Extraction We do Data Reduction



Left, Extraction. Right, Reduction by PCA.

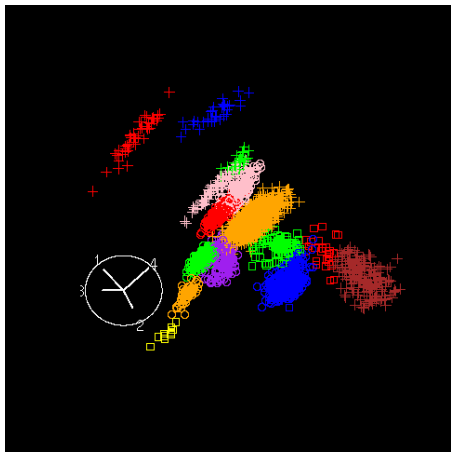
Sorting as It is Done Now

- Today most neurophysiologists perform spike sorting by hand, drawing contours on scatter plot matrices.
- Few automatic or semi-automatic methods are used. They use k-means or Gaussian mixture models fitted with the EM algorithm.
- Only one method can deal explicitly with events occurrence times.
- Very little clustering/classification theory is known and used by practitioners.
- The community has hard time recognizing the need for more rigorous methods.

What can R and GGobi Bring?

- Depending on the data sets 'simple' (kmeans) to more 'sophisticated' functions (EMclustN and bclust) are available.
- GGobi offers 2DTours allowing users to see and interact with high dimensional data. A tremendous help for users who do not want to learn the minimum about the theory underlying the method they use.
- R methods and classes allow (programmers and) users to easily visualize and interact with both data and analysis results.
- Many steps in the analysis can be easily parallelized thanks to snow and nws.
- Developers can work with Linux and users with Windows or MacOSX.

Thanks



- The developers of R, GGobi, mclust, e1071, etc.
- The Decrypton Project for financing us.