Exploring Parallelly Recorded Spike Trains

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The brain's huge computational power relies on its distributed architecture, with a highly interconnected network of constantly interacting individual units. Understanding the collective behavior of these units requires methods for visualizing multi-dimensional data. The current way of viewing spike trains from parallel recordings relies on rastergrams in which the display order of neurons can greatly influence one's ability to detect even the simplest spike patterns [1].

We propose a method which offers the means to interpret and visualize the complex dynamics of a set of parallelly recorded neurons. By considering the activity of all neurons at different points in time, we were able to describe, in a multi-dimensional space, the collective behavior of neurons. Using 3D Kohonen Maps, we projected the multi-dimensional space to a lower dimensional (3D) space of colors. Based on the projection, multi-dimensional vectors are coded by colors, considering their degree of similarity.

The method was applied to data recorded from cat area 17 under various stimulations conditions (gratings shown in Fig.1). Besides visualizing the time course of collective dynamics, we also quantified the variability of responses in different recording sessions. In addition, we provide quantitative analysis describing the trajectory of the system in the multi-dimensional space and compare the properties of multi-dimensional patterns with the properties of their constituent neurons: peri-stimulus time histograms, stimulus tuning, auto- and cross-correlation analysis. The method allows fast, flexible and intuitive data exploration, opening the way for efficient multi-dimensional analysis.

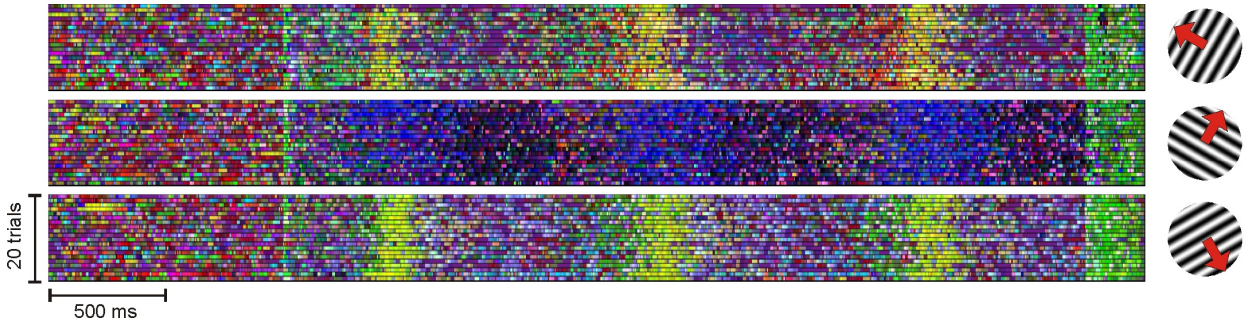

Fig.1. Activity of 26 simultaneously recorded single units from cat V1, stimulated with drifting sinusoidal gratings. Colored lines represent individual trials and are grouped by stimulation condition

References

[1] Methods for finding and validating neural spike patterns. J.V. Toups and P.H.E. Tiesinga, *Neurocomputing* 69:1362–1365, 2006.