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NeuroXidence: reliable and efficient analysis of an excess or deficiency of joint-spike events

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We present a non-parametric and computationally-efficient method named NeuroXidence (see http://www.NeuroXidence.com) that detects coordinated firing within a group of two or more neurons and tests whether the observed level of coordinated firing is significantly different from that expected by chance. NeuroXidence [1] considers the full auto-structure of the data, including the changes in the rate responses and the history dependencies in the spiking activity. We demonstrate that NeuroXidence can identify epochs with significant spike synchronisation even if these coincide with strong and fast rate modulations. We also show, that the method accounts for trial-by-trial variability in the rate responses and their latencies, and that it can be applied to short data windows lasting only tens of milliseconds. Based on simulated data we compare the performance of NeuroXidence with the UE-method [2,3] and the cross-correlation analysis.

An application of NeuroXidence to 42 single-units (SU) recorded in area 17 of an anesthetized cat revealed significant coincident events of high complexities, involving firing of up to 8 SUs simultaneously (5 ms window). The results were highly consistent with those obtained by traditional pair-wise measures based on cross-correlation: Neuronal synchrony was strongest in stimulation conditions in which the orientation of the sinusoidal grating matched the preferred orientation of most of the SUs included in the analysis, and was the weakest when the neurons were stimulated least optimally. Interestingly, events of higher complexities showed stronger stimulus-specific modulation than pair-wise interactions. The results suggest strong evidence for stimulus specific synchronous firing and, therefore, support the temporal coding hypothesis in visual cortex.

References

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