Neuronal spike time-series show self-affinity.

Almeida Filho, D.G.[a], Miranda, José G.V. [b] and Ribeiro, S [a]

[a] *Brain Institute, Federal University of Rio Grande do Norte, Natal, Brazil.*
[b] *Physics Institute, Federal University of Bahia, Salvador , Brazil.*

Abstract. In neuroscience, the neuronal spike time-series analysis is one of the most important contemporaneous methods for studying the nervous system physiology. In this method, the main feature used to determine whether a place or region is involved in a specific behavior is the increase or decrease of the neurons spike frequency (firing rate-FR) during the behavior manifestation. The aim of our study is to determine whether the temporal fluctuation of FR carries information about the neurons functionality, and consequently, reflects physiological changes during specific behaviors. The dataset analyzed comprises spike trains from four rats recorded across the sleep-wake cycle, as the animals traverse three experimental intervals: before (01 hour), during (20 minutes) and after (02 hours) the exploration of new objects in the dark. Three different neural regions were recorded: Hippocampus (HP - related to memory acquisition), Somatosensory Cortex (S1 - involved in tactile detection and discrimination) and Primary Visual Cortex (V1 - involved in visual processing). We used Detrended Fluctuation Analysis (DFA) of a 500 points one-step sliding window of FR fluctuation along the complete time-series, exploring values of Hurst Exponent across behavioral states and experimental epochs. Preliminary results show a self-affine dynamic for FR bin sizes ranging from 5 to 45 milliseconds, indicated by a log X log linear approximation around 99%. In addition, neurons within the same region exhibit a high variability of the Hurst Exponent, indicating no anatomical specificity of the Hurst Exponent in our dataset. Finally, we found major differences in self-affinity in the same neuron when distinct experimental intervals were considered. Future analysis will advance the use of the Hurst exponent and Multifractality to investigate possible self-affinity differences for different behavioral states and experimental epochs.

Keywords: neuronal spike time-series, firing rate, self-affine dynamic, Detrended Fluctuation Analysis (DFA), Hurst exponent.
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