# Detecting spiking pairwise functional connectivity beyond linear predictions: a comparative study

Raul Adell Segarra[1], M. Vila-Vidal[2], A. Tauste Campo[1]

[1]Computational Biology and Complex Systems, Department of Physics, Universitat Politècnica de Catalunya, 08028 Barcelona, Spain
[2]BrainFocus Labs, S.L., 08750 Barcelona, Spain

### Abstract

In this study, we tackle the challenge of mapping out neural interactions, a task complicated by the limitations of traditional pairwise statistical methods amidst technological advances in simultaneous neuronal activity recordings. We examine the efficacy of non-linear statistical measures against traditional linear methods in identifying functional connections between neuronal spike trains. Specifically, we focus on multivariate autoregressive models and information-theoretic approaches to detect single-trial directed statistical associations. Our investigation explores the influence of non-linearity and the memory order on the accuracy and reliability of interaction detection. Through data-driven Markovian techniques, we generate synthetic spike-train pairs that simulate realistic cortical interactions, allowing for an extensive evaluation of sensitivity and specificity of linear vs. non-linear methods. Moreover, we apply these methodologies to real data, showcasing the trade-offs between improved detection capabilities and computational demands. This research not only navigates the analytical complexities of neuronal data but also illuminates the strengths and weaknesses of existing methods, contributing valuable insights into the inference of neural information processing patterns from spiking recordings.