An analysis of the temporal component of motor preparation and execution in High Frequency Local Field Potentials: A Theoretical Approach | Marc Burillo Garcia

Authors: Marc Burillo[1,2], Michael Depass[1,3] & Ignasi Cos[1,4]

1Departament de Matemàtiques i Informàtica, Universitat de Barcelona, Barcelona, Spain

2Sorbonne Université, France

3Universitat Pompeu Fabra, Barcelona, Spain

4Institutes of Neuroscience & Mathematics, Universitat de Barcelona, Spain

Electrophysiological recordings have been the fundamental source of brain inner information crucially contributing to current understanding of brain function and dynamics. Typically recorded in the context of controlled laboratory tasks, state-of-the-art multi-electrode arrays can nowadays provide simultaneously recorded high dimensional time-series from across several brain areas, providing an unprecedented insight onto brain dynamics. However, as their richness and complexity increases, obtaining reliable methods yielding interpretable characterizations of the underlying neural substrate remains a matter of vivid interest. In so far, most neural time-series analyses are typically reduced to pairwise electrode statistics, such as cross-correlation and granger causality. Furthermore, it is most often the case that the golden-data neural datasets recorded during specific tasks encompass a few sessions alone, questioning the use of data voracious techniques. For example, deep learning neural networks come at the expense of reduced interpretability and the requirement of prohibitively large datasets. Our purpose here is to provide exploratory techniques aimed at providing rich statistical characterizations of spatiotemporal brain dynamics within the constraint of modest, multivariate dataset time-series recordings. In brief, we describe the use of a vector autoregressive-machine learning pipeline to characterize spatio-temporal dynamics of high frequency local field potentials recorded during a movement planning and execution task by means of Utah arrays implanted in the motor areas of a non-human primate. By contrast to basic cross-correlations and granger-causality analyses, our pipeline provides a principled analysis of multivariate time series while preserving dataset and results interpretability. Importantly, the

classification accuracies from single-electrode analysis suggest *high degree of intra-region heterogeneity*, while multi-electrode achieved highest accuracies confirming a network behaviour and the suitability of a more complex description than simply paired time series analysis. In summary, this technique provides a reliable method to characterize the multivariate spatiotemporal neuro-dynamics of motor related brain states using a single session dataset, while preserving high accuracy and interpretability.