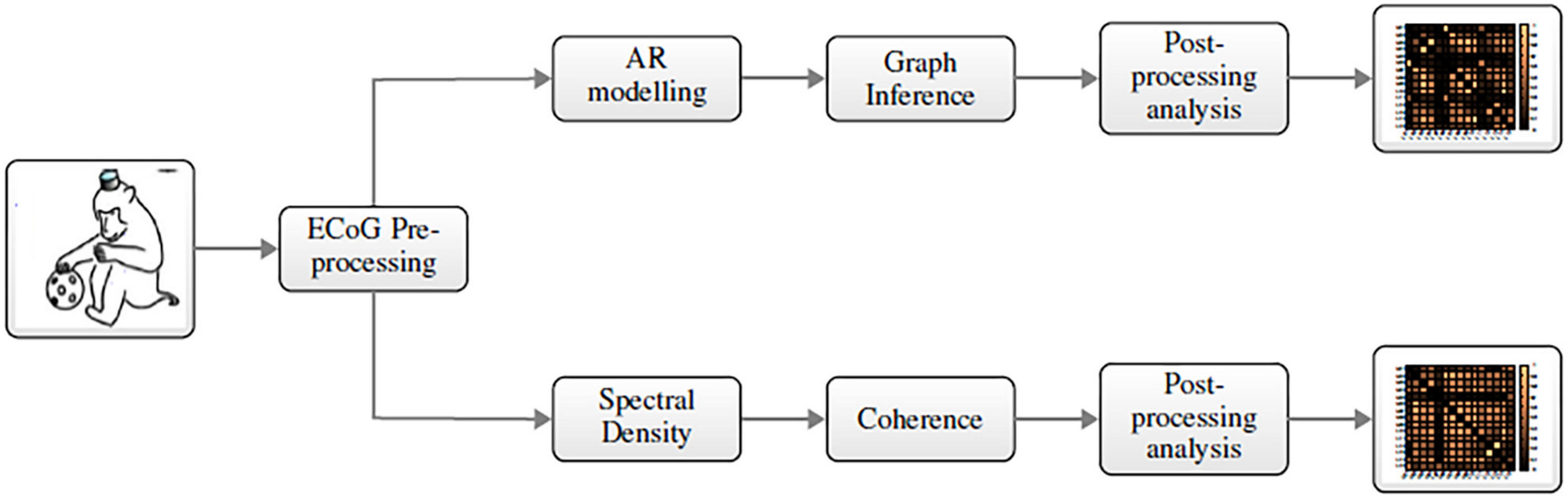
Inferring Functional Connectivity in Primates Using Graph Signal Processing

Finding cortical connectivity remains one of the major challenges of computational neuroscience. We present a method based on the new signal processing concept of Graph Signal Processing to estimate the functional connectivity of primates' brains from Electrocorticography (ECoG) signals alone. In this method, ECoG electrodes are modelled as the nodes of a graph whose edges represent the cortical connectivity. The ECoG signals are considered the signals on the graph. The auto-regressive models of the recorded ECoG signals are used to infer the underlying graph. The method is based on the maximization of graph smoothness, which is defined as the quadratic graph Laplacian. The outcome of this optimization algorithm is the Laplacian matrix of the graph, which will be used to obtain an undirected adjacency matrix of the graph. The adjacency matrix represents an estimate of the cortical connectivity map of the brain area in which the ECoG electrodes are placed. The proposed method reproduces the directly measured synaptic connectivity between electrode sites more accurately than the traditional coherence measures. This finding opens the door for a new technique that could closely relay connectivity data in situations where it is impractical to experimentally determine stimulation-based connectivity strengths.

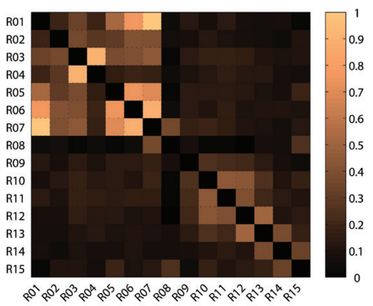
Siddhi Tavildar, *Ashkan Ashrafi and Eberhard Fetz*

This research is supported by the National Science Foundation (EEC-1028725) grant, and the Computational Science Research Center (CSRC) at San Diego State University

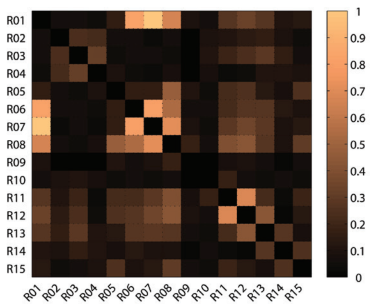


Block diagram for computing the connectivity map using spontaneous ECoG data

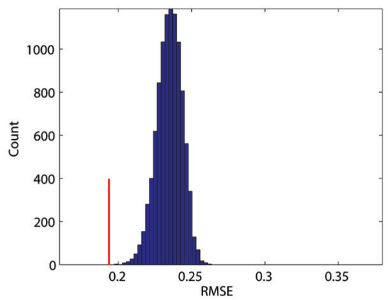
Right Hemisphere



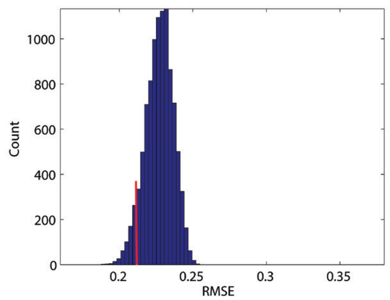
Graph Inference Connectivity map



Coherence Connectivity map

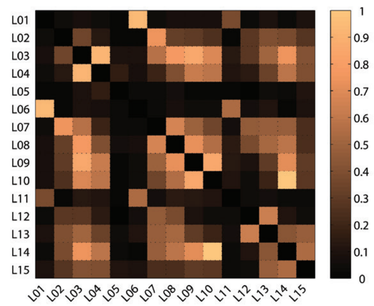


Graph Inference Error Distribution

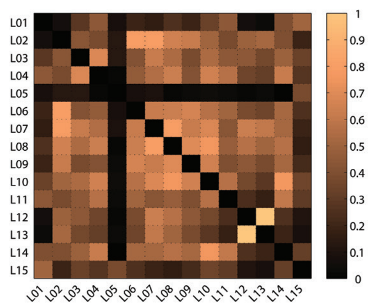


Coherence Error Distribution

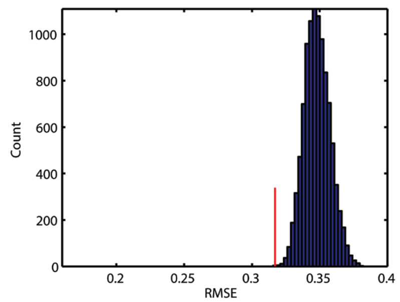
Left Hemisphere



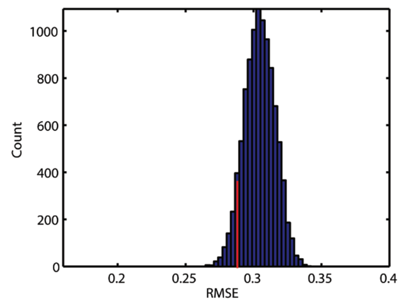
Graph Inference Connectivity map



Coherence Connectivity map



Graph Inference Error Distribution



Coherence Error Distribution