Identification of epileptogenic networks using edge-centric dynamic connectomics

Drug-resistant epilepsy affects approximately 30% of epilepsy patients, for whom precise localization of the seizure onset zone (SOZ) is critical for surgical planning. We propose a biomarker based on intracranial EEG (iEEG) recordings using dynamic edge-centric networks and hyperparameter-free algorithms to detect seizure onset zones. Our hypothesis is that electrodes within the epileptogenic network exhibit anomalously increased synchronization during ictal compared to preictal periods. To take advantage of this, edge-centric networks are used which, unlike node-centric approaches, capture pairwise synchronization dynamics directly, offering finer spatial resolution of propagation pathways. By parametrizing a Beta distribution over pairwise coherence values during the preictal period, we model the baseline connectivity of all electrode pairs. Anomalous coherence values during the ictal period are then used to infer a weighted undirected dynamic graph. Moreover, using a max-product path algorithm inspired by epidemic spreading models, the directionality of the edges is obtained which is shown to enhance source localization. Preliminary application of this method 3 patients suggests his framework offers a principled, computationally efficient, and fully data-driven approach to characterizing epileptogenic networks from iEEG recordings.