Differential Connectivity Graph: Application on the Identification of Leading Epileptic Regions

In this presentation, a new graph analysis method: Differential Connectivity Graph (DCG) is aimed to be explained. DCG is a robust method for identification of discriminative connections between two states. When the data includes a mixture of interested and uninterested events, it is complicated to extract the graph specific to the interested event. DCG is developed to extract the most statistically significant connections related to the interested event by decreasing the effect of uninterested event. DCG is robust due to 1) large number of sample size, and 2) powerful statistical methods like permutation. DCG nodes include regions involved in the interested event either source, sink, or transit. To differentiate between source and other sink or transit nodes, we propose a new graph measure: local information (LI). DCG can be calculated for different frequency bands. To infer a set of source nodes from LI values of different DCGs, a multi-objective optimization method (Pareto) is used.

The DCG method is applied on the intracerebral EEG (iEEG) recordings of five epileptic patients to identify the leading epileptic regions (source nodes). The method is applied on the iEEG recordings of five patients. The estimated leading epileptic regions are congruent with visually inspected results provided by the epileptologist.

Common Spatial Pattern: Application on the Identification of Brain Regions Involved in Epilepsy

Drug-resistant epileptic patients are recommended to undergo resective surgery. The aim of this resective surgery is to remove brain regions responsible for the seizures without causing new neurological deficits. For the presurgical evaluations, different clinical information is needed. The interictal epileptiform discharge (IED) regions can provide a part of this information.

To identify the IED regions, we are interested in reducing the effect of background activity. For this purpose, we use common spatial pattern method. This method is well suited for identification of discriminative sources between two classes. For our application, these two classes are IED and non-IED. We use periods including IED, and periods excluding IEDs or abnormal physiological signals in CSP. As such we extract the most relevant temporal sources, and eventually the most relevant brain regions to IEDs.

The method is applied on the intracerebral EEG (iEEG) recordings of one seizure-free patient after resective surgery. The results are compared with seizure onset zones visually inspected by the epileptologist. The congruent IED regions with visually detected seizure onset zones are encouraging results. Moreover, the application of CSP method for the identification of IED regions seems interesting as this method is fast and simple.