Advancing epilepsy treatment with computational modeling: from SEEG data to personalized models of seizure spread

The use of personalized computational models for treating epilepsy is a promising direction of study in epilepsy. Hybrid Brain Models (HBM) merge detailed data of brain structure (from MRI, DTI scans) and brain activity (from SEEG recordings), offering a novel way to model brain dynamics and investigate how therapeutic interventions might benefit epilepsy treatment. We introduce a method to customize these models based on SEEG data, creating networks that mimic the connections in specific brain areas affected by epilepsy and reproduce the pattern of seizure activity in the patient's brain.

The personalization of SEEG network models requires the assimilation of SEEG and DTI data from the patient. SEEG data is analyzed to obtain a classification of contacts according to their epileptogenicity, which serves as the basis for the creation of a model of the network. The connectivity between nodes is based on the DTI information of the subject. We adjust several model parameters (global coupling between nodes, excitability of the nodes), so that the seizure propagation pattern matches the one observed in real SEEG recordings. In the empirical and the model-generated data, the seizure propagation is captured by the functional connectivity between the amplitude envelope of SEEG signals during seizure.

We present the personalization of SEEG networks for different epilepsy patients. The model can reproduce the SEEG activity recorded in the most epileptogenic nodes, as well as the propagation of the seizure in the network. This work represents a significant step towards the personalization of network models using multimodal data, offering insights into the dynamics of seizure propagation. It underscores the potential of HBMs as valuable tools in the development of personalized therapy for epilepsy treatment.