The Detection of Anomalies in EEG Data Using Diffusion Geometry

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EEG data are recorded from patients with epilepsy, and the data can also be analyzed to determine information about how brains function. Large-scale networks may play a role in the generation of seizures and their spread. If they can be reliably defined, then they may suggest alternate methods for controlling seizures. Several methods are available to use in the determination of synchronization of neurons in the brain. Epilepsy is an extreme example of synchronization, so it is natural to consider patients with epilepsy when studying how the synchronization of neurons develops. In particular, it is important to determine if a seizure starts from a focus or a network as it is critical to determine treatment possibilities.

A powerful way of analyzing EEG data is by using diffusion mapping. With this method, eigenfunctions of Markov matrices are used to construct coordinates that generate efficient representations of complex geometric structures. Initially, a matrix describing local affinities is constructed and then normalized to become a Markov matrix. Selected eigenfunctions of this matrix are chosen to make the diffusion map embedding in a lower dimensional Euclidean space.

Not only does diffusion mapping allow for dimensionality reduction of the data, but this method also provides pattern recognition in the data so that specific parts of the data may be analyzed more closely. It is a useful tool in detecting anomalies in EEG data and determining whether a brain is functioning normally or not.

Diffusion maps extend principal components analysis and provide a nonlinear approach. The geometry of the data in the diffusion mapping is used to detect anomalies in the data. Consequently, the pre-seizure data in patients with epilepsy may be extracted to determine if there are any anomalies that may help predict the occurrence of a seizure.