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Model and data-driven representations of the sleep cycle using locally linear embedding

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Introduction

There is a complex relationship between sleep and the onset of epileptic seizures. Current methods of sleep scoring divide data into discrete stages, but a continuous model may provide more insight into this phenomenon. This would not only allow a more detailed analysis of the sleep leading up to the seizure, but it would give us greater predictive power regarding impending transitions. Continuous models of the human sleep cycle already exist; however, it is very difficult to connect these models to actual EEG sleep data. Here we present a possible solution to this problem using a technique called locally linear embedding (LLE).

Method

LLE is a method for discovering the structure of high-dimensional data by projecting it to a lower-dimensional manifold. It accomplishes this by characterizing the local structure around each data point (based on its "nearest neighbors") and then computing a nonlinear re-mapping of the data that optimally preserves that local structure [1]. Here we apply the LLE algorithm to both human EEG data recorded during sleep and simulated EEG data from a continuous mathematical model of the sleep cycle [2]. The data starts in a 7-dimensional feature space based on power in three frequency bands and several statistical measures; we then project each one into a 2-D space and compare the resulting structures.

Results

First, we look at the result of running the LLE algorithm on sleep EEG data gathered from epileptic patients undergoing surgical evaluation at the UC San Francisco Epilepsy Center. The projection into 2-D space reveals three overlapping lines, each one associated with different EEG characteristics. Next, we examine the effect of applying LLE to data generated by a mathematical model of the sleep cycle. Again, we see distinct clusters of points based on the properties of the input data. The two sets of LLE results can then be directly compared; this allows us to take an EEG data point and find its analogous point in the projection of the simulated data, thereby determining its position in the sleep cycle.

Summary

These results represent the first steps toward connecting EEG sleep data to a continuous mathematical model of the human sleep cycle. This type of analysis not only provides a more detailed picture of sleep stages and the transitions between them, but it may also have implications for the prediction of epileptic seizures.

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References

1. Saul LK, Roweis ST, Singer Y: **Think globally, fit locally: unsupervised learning of low dimensional manifolds.** *J Machine Learning Research* 2003, **4:**119-155.
2. Steyn-Ross DA, Steyn-Ross ML, Sleigh JW, Wilson MT, Gillies IP, Wright JJ: **The sleep cycle modelled as a cortical phase transition.** *J Biological Physics* 2005, **31:**547-569.