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Letter to the Editor

Performance of a seizure warning algorithm based on the dynamics of intracranial EEG

To the Editor,

We read with great interest the article by Chaovalitwongse et al. (2005) who studied the performance of an automated seizure warning algorithm developed by this group. The algorithm, which is based on concepts from nonlinear dynamics and optimization theory, was applied to 2100 h of intracranial EEG recordings from 10 patients with medically intractable temporal lobe epilepsy, comprising a total of 158 seizures. The authors divided the data by taking the first 50% of seizures from each patient as training set and the remaining seizures as test set. Optimum parameter values for their algorithm were determined for the training set (in-sample optimization) and subsequently used for the test data (out-of-sample evaluation). Assessment of the algorithm's performance for the test data yielded a sensitivity of 68.75% with a false prediction rate of 0.15 per hour. The statistical significance of these results was examined by re-evaluating the performance of the warning algorithm for a virtual seizure data set (surrogate seizure times).

The statistical test used in this study, i.e., the concept of surrogate seizure times, was introduced by Andrzejak et al. (2003) and has previously been applied to long-term EEG recordings (Mormann et al., 2005). Formally, surrogate seizure times can be used to test the null hypothesis that a given algorithm cannot detect a pre-seizure state with a performance above chance level. For this test, a set of artificial (surrogate) seizure onset times are generated, e.g., by randomly shuffling the original inter-seizure intervals jointly for the training and test seizures of each patient. The performance of the warning algorithm is then re-evaluated on the original EEG data using the surrogate seizure times instead of the original seizure onset times. Only if the performance of the algorithm for the original seizure times is better than the performance for a number of independent realizations of the surrogate seizure times, can the null hypothesis be rejected. Only in this case can the algorithm be regarded as significantly better than a random predictor.

A surrogate test of this kind requires that the steps carried out in determining the performance values of the algorithm are repeated in the very same way for each set of surrogate seizure times as for the original seizure times. In particular, any type of optimization process used for the original data must also be applied to the surrogate data.

Unfortunately, this essential requirement was not fulfilled by the authors. Instead of re-running the parameter optimization procedure for every training set generated from the surrogate seizure times, they re-used the parameters obtained in the in-sample optimization for the original seizure times to evaluate the performance for the test sets generated from the surrogate seizure times. This introduces a potential bias and renders the statistical validation invalid.

While this study meets some standards for an evaluation of a prospective seizure warning algorithm in terms of long, continuous data sets and an out-of-sample performance estimation, it fails to prove that the warning algorithm used by the authors indeed performs better than chance.

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