Spike-and-wave epileptiform discharge pattern detection based on Kendall's Tau-b Coefficient

Joaquin Ems[1], Lourdes Hirschson[1], Catalina Carenzo[1],
Valeria Muro[2], Carlos D'Giano[2], Antonio Quintero-Rincón[1]

[1] Department of Bioengineering, Instituto Tecnológico de Buenos Aires, Argentina.
[2] Fundación contra las Enfermedades Neurológicas Infantiles (FLENI), Argentina.

Contact: dracca@itba.edu.ar

Abstract

Epilepsy is a main public health issue. An appropriate epileptiform discharges pattern detection of this neurological disease, is a typical problem in biomedical engineering. In this paper, a new method is proposed for spike-and-wave discharge pattern detection based on Kendall's Tau Coefficient. The proposed approach is demonstrated on a real dataset containing spike-and-wave discharge signals, where our performance is evaluated in terms of high Specificity, rule in (SpPIn) with 94% for patient-specific spike-and-wave discharge detection and 83% for a general spike-and-wave discharge detection.

Methodology

Dataset: 780 monopolar 256 Hz signals from 10 patients from FLENI: 390 spike-and-wave discharges and 390 healthy signals.

Selected Data: 300 spike-and-wave discharges were selected by an expert neurologist from FLENI based on the ability to see the seizure.

Epochs: A rectangular sliding-window of the same length of each spike-and-wave discharge from the dataset.

Statistical parameter: Kendall's Tau-b Coefficient (τ) and its p-value were used to measure the ordinal association or concordance between two morphological waveforms signals.

Classifiers: Linear discriminant, quadratic discriminant and support vector machine learning techniques with the input vector $[\tau, p]$ were used to predict between spike-and-wave and non-spike-and-wave.

## Kendall's Tau-b Coefficient

- Kendall's Tau-b coefficient is a nonparametric correlation analysis used to measure the ordinal association or concordance between two measured quantities: each spike-and-wave epileptiform discharge from dataset with each EEG epoch.

- The goal is to estimate the statistical relationship between a spike-and-wave epileptiform discharge against each EEG segment by channel, in order to quantify and detect the morphological similarity or concordance between signals.

## Spike-and-wave epileptiform discharge waveforms
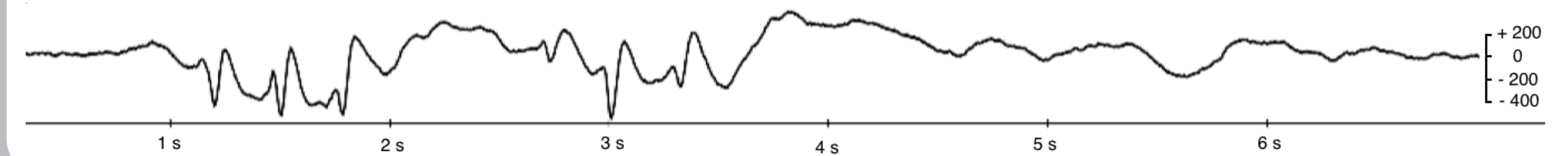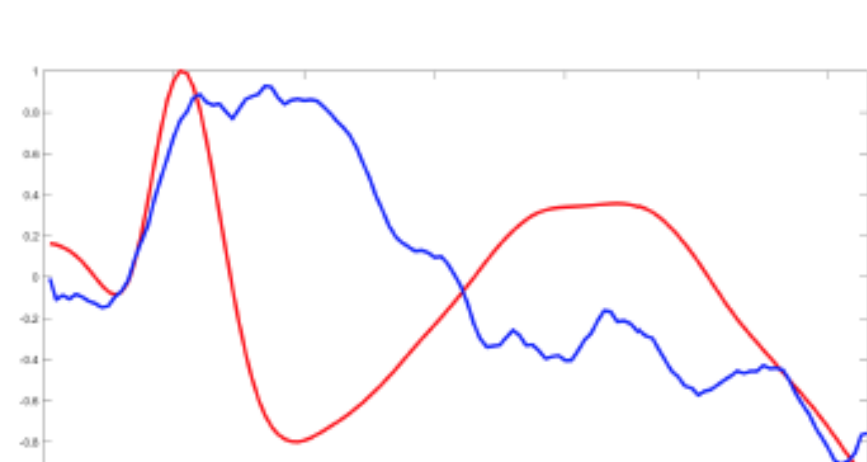

Results and Discussion

- In total 3080 τ and p-values were estimated in 140 segments by each channel. The obtained and p-values for each segment per channel were corroborated with the medical annotations by visual inspection.

- Based on this analysis, a threshold $\tau = 0.5$ and p-value = 0.05 were selected in order to perform a ROC analysis.

- The Tau-b statistic value was assigned to the annotated data and the values obtained were compared with the threshold value; and later added to the confusion matrix in order to assign a specificity and sensitivity metric value.
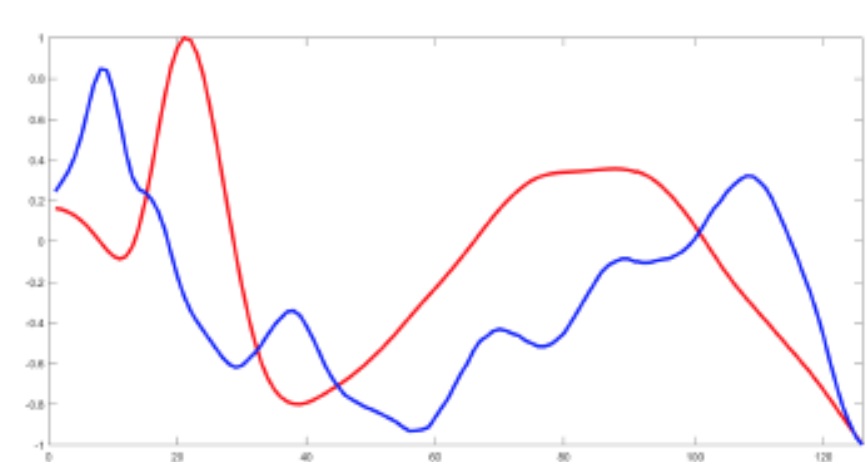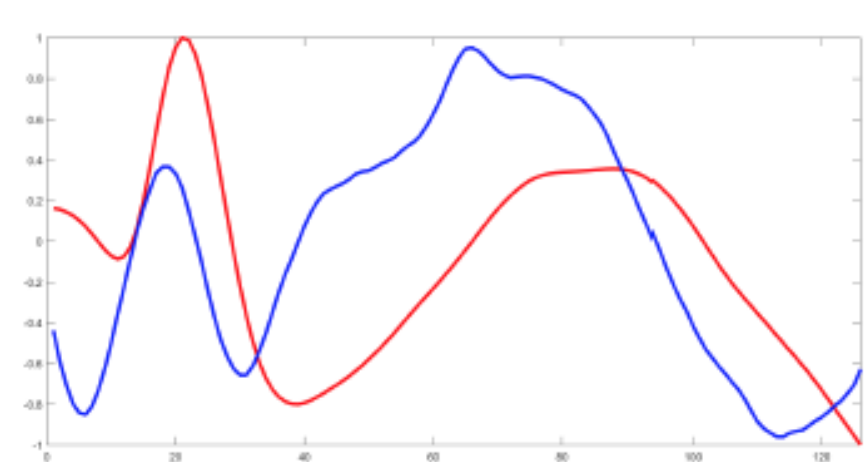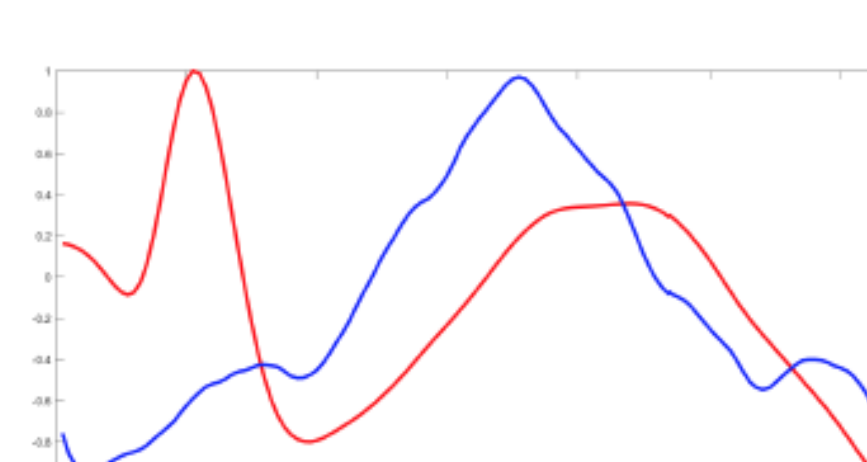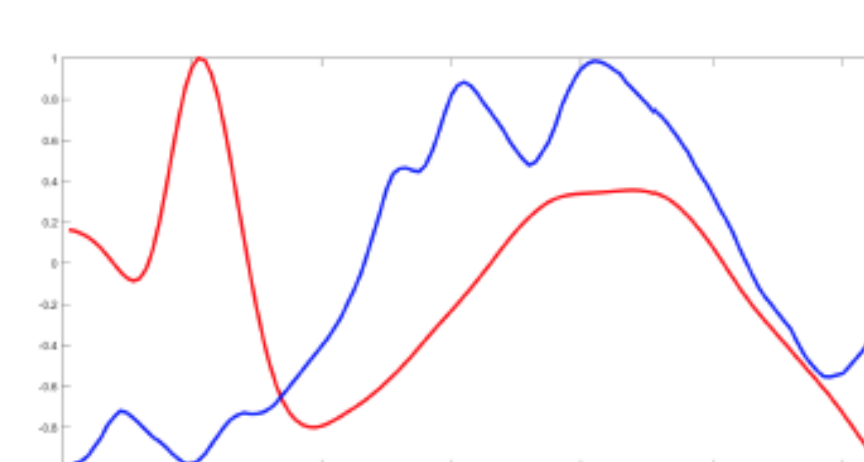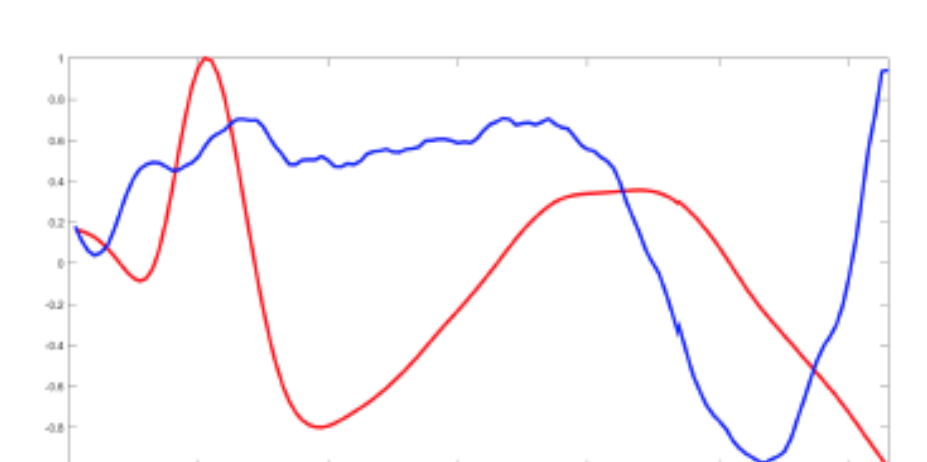

(a) Annotated example (b) Candidate example (c) Annotated example (d) Candidate example (e) Annotated example (f) Candidate example

The percentage of correct classifications was analyzed only in terms of high Specificity, rule in (SpPIn).

- SpPIn for a general patient: 83%

- SpPIn focused on patient-specific spike-and-wave detection: 94%

The research reflected in this paper suggests that our method is possible to train a classifier and detect with a small dataset.

Publications, awards and acknowledgements

ITBA Group