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EPILEPTIFORM SPIKE TEMPLATE SELECTION USING DYNAMIC TIME WARPING AND AFFINITY PROPAGATION

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1. BACKGROUND

Epilepsy is a group of chronic brain disorders characterized by unprovoked seizures. 50 million people are affected, as reported by WHO in 2004. The spikes in EEG are biomarkers for epilepsy. Diagnosis based on spike detection is tedious as experts have to monitor the EEG recordings for hours or days. The spike patterns also show high variation in morphology between patients. We applied clustering to extract proper spike templates, to facilitate faster and accurate spike detection, and ultimately, more reliable diagnosis of epilepsy.

2. METHODS AND DATA

Scalp EEG of 12 patients, from Massachusetts General Hospital, with spikes annotated by two neurologists, independently.

- ❑ Blocks of 30 minutes of recordings from 19 scalp electrodes
- ❑ Sampling rate of 128Hz
- ❑ High-pass filter at 1Hz to remove baseline fluctuations
- ❑ Notch filter at 60Hz to remove power line interference
- ❑ Common average referential montage

We analyzed the results of two clustering algorithms, Affinity propagation and K-means, with distance measures, Dynamic Time Warping (DTW) and Euclidean distance (ED).

K-means clustering was analyzed in two ways:

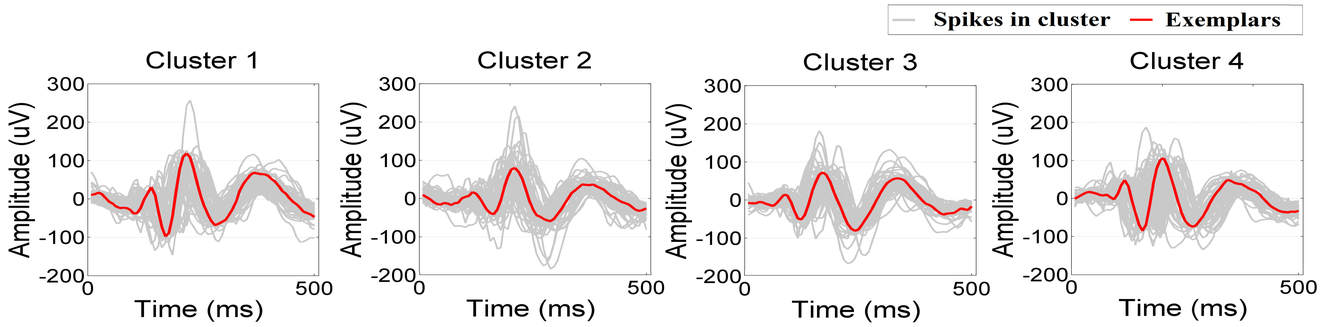
- ❑ K-means directly on the spike waveforms.
- ❑ K-means on a 3D feature vector extracted from the spikes.

The features used are:

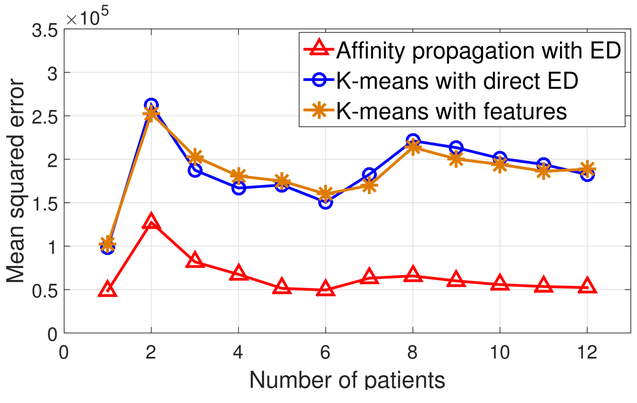
- ❑ Peak-to-peak value
- ❑ Width of spike
- ❑ Non-Linear Energy Operator

The clustering techniques were compared based on mean squared errors and the distance measures using t-distributed stochastic neighborhood embedding (t-SNE).

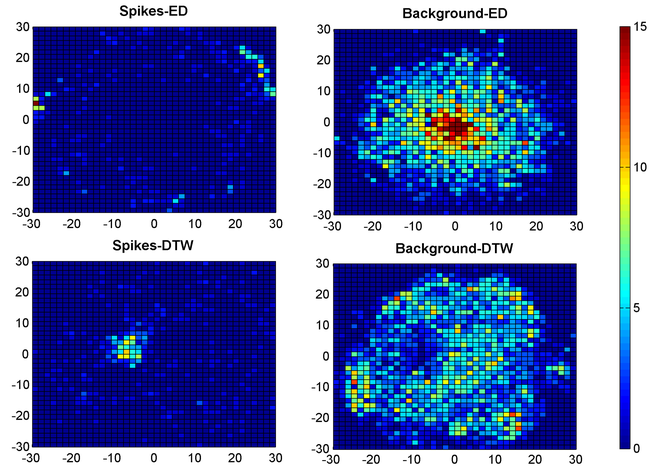
3. RESULTS



The spikes in the largest four clusters generated by affinity propagation with DTW.



The mean squared error values are significantly lower for affinity propagation in comparison with K-means clustering.



Density plots using t-SNE, indicating DTW groups spikes better than ED.

4. CONCLUSION

Affinity propagation in conjunction with DTW is an effective method for clustering epileptic spikes and identifying the templates. In future, we will develop algorithms to select the proper number of templates. The resulting templates will then provide an operational definition of interictal spikes and also help in developing an efficient template based automated spike detection system.

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