Searching for Waveforms on Spatially-Filtered Epileptic ECoG

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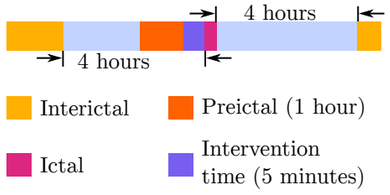
Problem definition

- The shape of neural oscillations (Cole, 2017)
  - discriminate bewteen disease states
  - contain physiological information
  - distinguish oscillatory processs located in close brain regions and in the same spectral band
- The data-driven search of waveforms in EEG data for seizure prediction is almost absent in the literature.

The data

Name	C	Preictal	Interictal
HUP070	63	2h 6m	40h 32m
HUP078	101	1h 30m	45h 23m

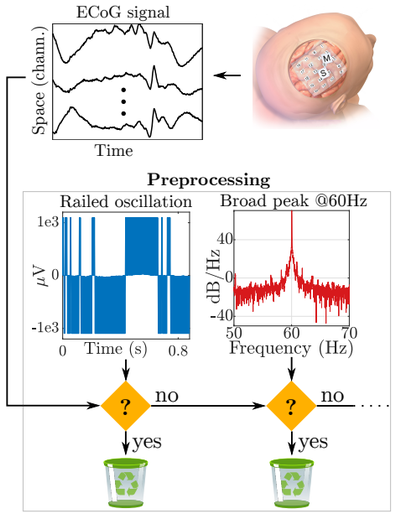
- Each ECoG signal is split into preictal and interictal segments, as follows:



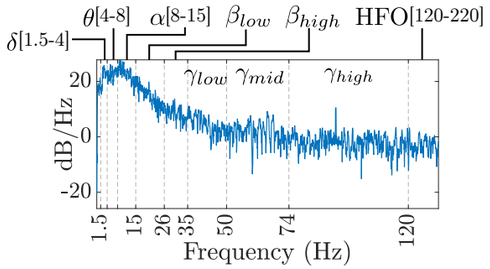
Glossary

ECoG: Electrocorticography
EEG: Electroencephalography
CSP: Common spatial patterns
AUC: Area under the ROC curve
HFO: High Frequency Oscillations

Methods

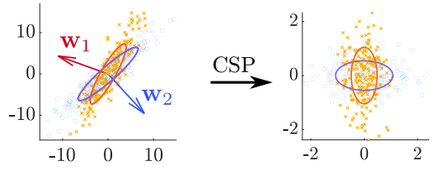


- Analyze in nine spectral bands:

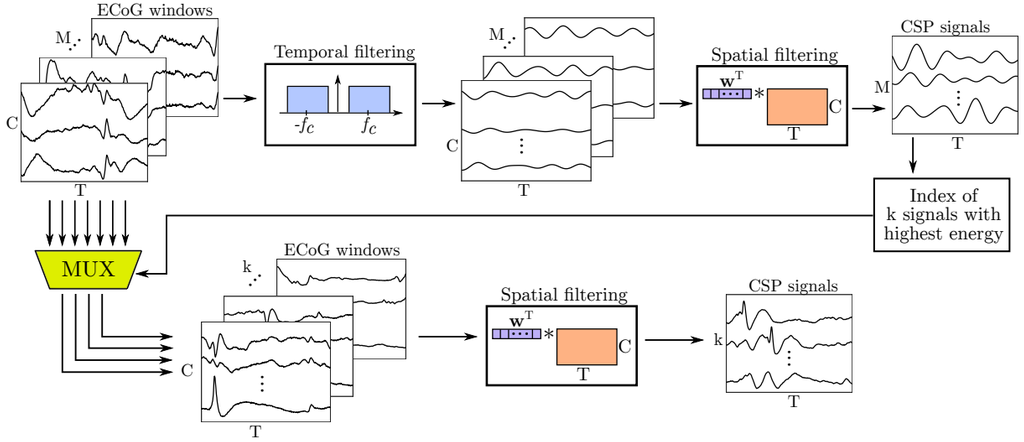


- Compute spatial filters using temporally-filtered data and the CSP method:

$$\mathbf{w}_i = \arg\max_{\mathbf{w}} \frac{\mathbf{w}^{\mathrm{T}}\boldsymbol{\Sigma}_i\mathbf{w}}{\mathbf{w}^{\mathrm{T}}(\boldsymbol{\Sigma}_1+\boldsymbol{\Sigma}_2)\mathbf{w}}, \quad i=1,2$$



- Waveform search strategy:

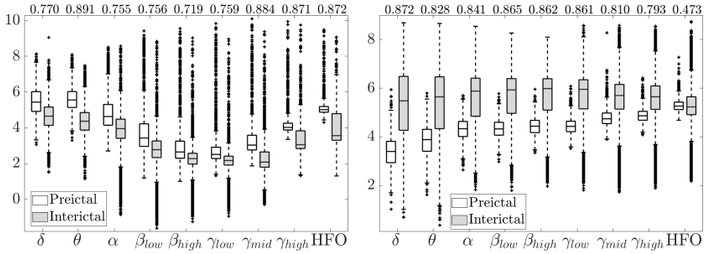


Contribution

A waveform search strategy to find spatially-filtered waveforms on ECoG data that can be used to discriminate between the preictal and interictal state of an epileptic recording.

Results

- The discriminatory performance of CSP filters was
  - quantified using the AUC of a binary classifier
  - high for both filters in HUP078
  - low for $\mathbf{w}_2$ in HUP070 due to large-energy artifacts
- Log-energy (μV^2) of CSP signals in HUP078 filtered with $\mathbf{w}_1$ (left) and $\mathbf{w}_2$ (right). Numbers in the top axis are AUC values:



- Top 10 CSP signals in HUP078 with highest energy from each condition, after applying the $\mathbf{w}_1$ optimized for the γ_{mid} band:

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