Labeling EEG Components with a Bag-of-Waveforms from Learned Dictionaries

Carlos Mendoza-Cardenas, Austin Meek, Austin J. Brockmeier

Overview

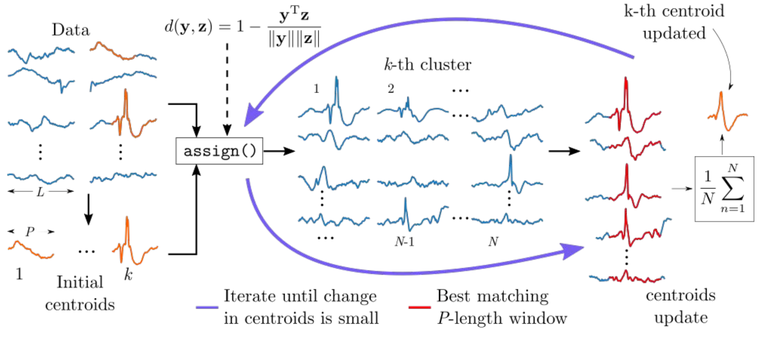
- EEG analysis has clinical value for diagnosing diseases and for basic research in brain functions
- EEG signals are compositions of independent signals, including noise
- Classifying the sources of these signals is important for proper EEG analysis

Bag-of-Waves

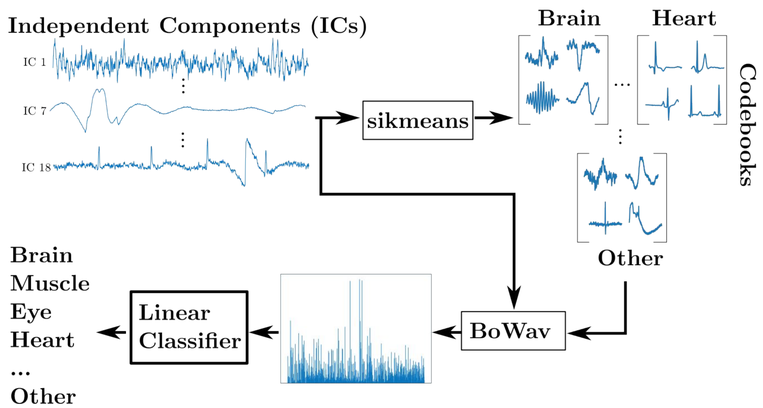
- Our approach, bag-of-waves (BoWav), provides a new feature for EEG IC classification
- BoWav is an adaptation of bag-of-words from NLP
- BoWav outperforms the previous SOTA, ICLabel (Pion-Tonachini et. al, 2019) in two out of three classes of interest

Methods and Data

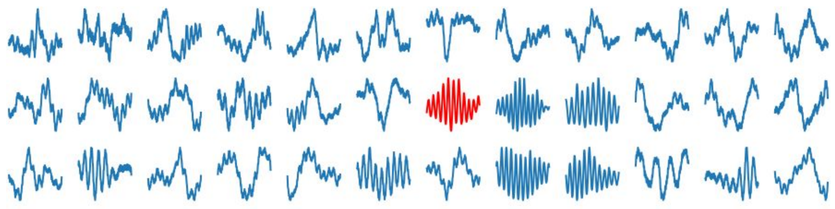
- Our dataset contains 34 subjects (Onton & Makeig, 2022), with 7 used for testing
- We use a shift-invariant *k*-means algorithm (Mendoza-Cardenas & Brockmeier, 2021) to learn codebooks
- These codebooks are fed into our BoWav algorithm
- ICs then classified into seven different categories, such as brain and muscle
- We compare our results against those of ICLabel



Experiments and Results



Representative ICs from the Brain class. In red, a waveform with a strong α-rhythm at 10 Hz.



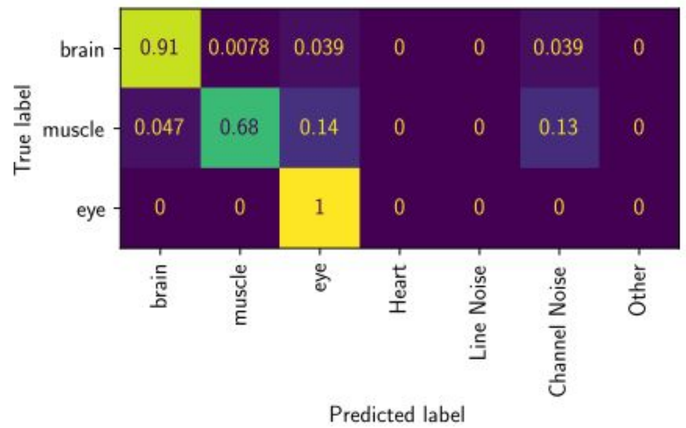
Benefits and Further Work

There are many benefits to our approach:

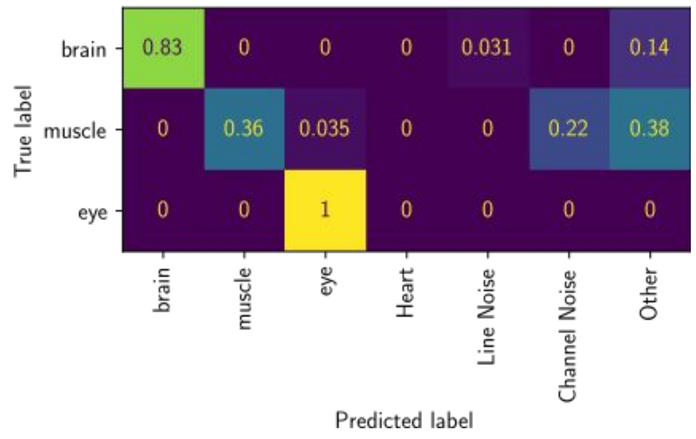
- Outperforms previous SOTA in two out of three classes of interest
- Highly interpretable, as each codebook learned is representative of each class

Possible extensions include:

- Incorporating Power Spectral Density (PSD) and autocorrelation features
- Using other methods to learn codebooks such as Quick Shift Matrix Profile (QSMP)
- Trialing different techniques from NLP



Above is the performance of BoWav on expert provided labels, and below is the performance of ICLabel.



References

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Luca Pion-Tonachini, Ken Kreutz-Delgado, and Scott Makeig. ICLabel: An automated electroencephalographic independent component classifier, dataset, and website. Neuroimage, 198:181–197, 2019. ISSN 10959572.

Julie Onton and Scott Makeig. Imagined Emotion Study. OpenNeuro, 2022.