A deep learning architecture for temporal sleep stage classification using multivariate and multimodal time series

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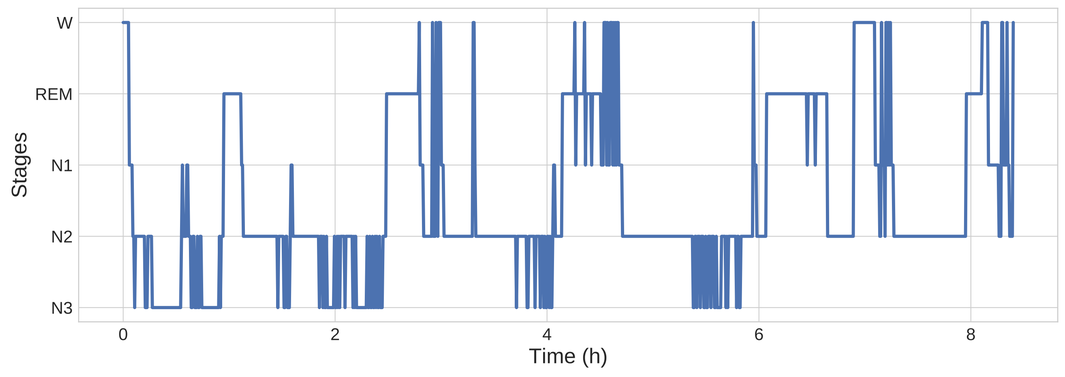
Motivation

Sleep stage classification from EEG, EOG, EMG



- New deep architecture to grasp spatial and temporal contexts
- Quantify the importance of spatial and temporal contexts

Temporal classification problem

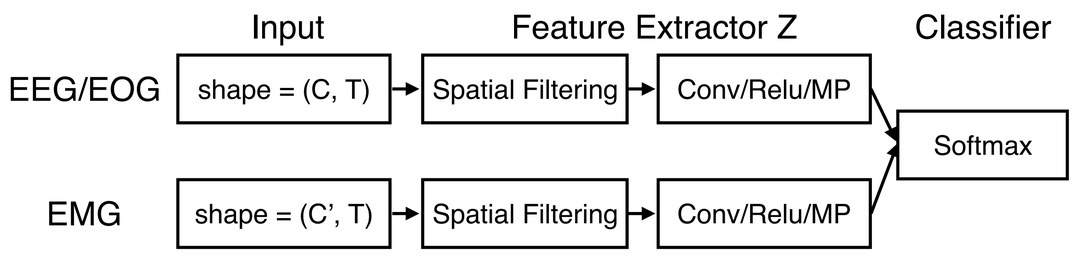
Data: samples of multivariate time series, $X \in \mathbb{R}^{C \times T}$ with its label $y \in \{W, N1, N2, N3, REM\}$ (C: number of channels, T: number of time steps).

$\{X_t, X_{t+1}, \cdots, X_{t+k-1}\}$ an ordered sequence of k neighboring segments of signals.

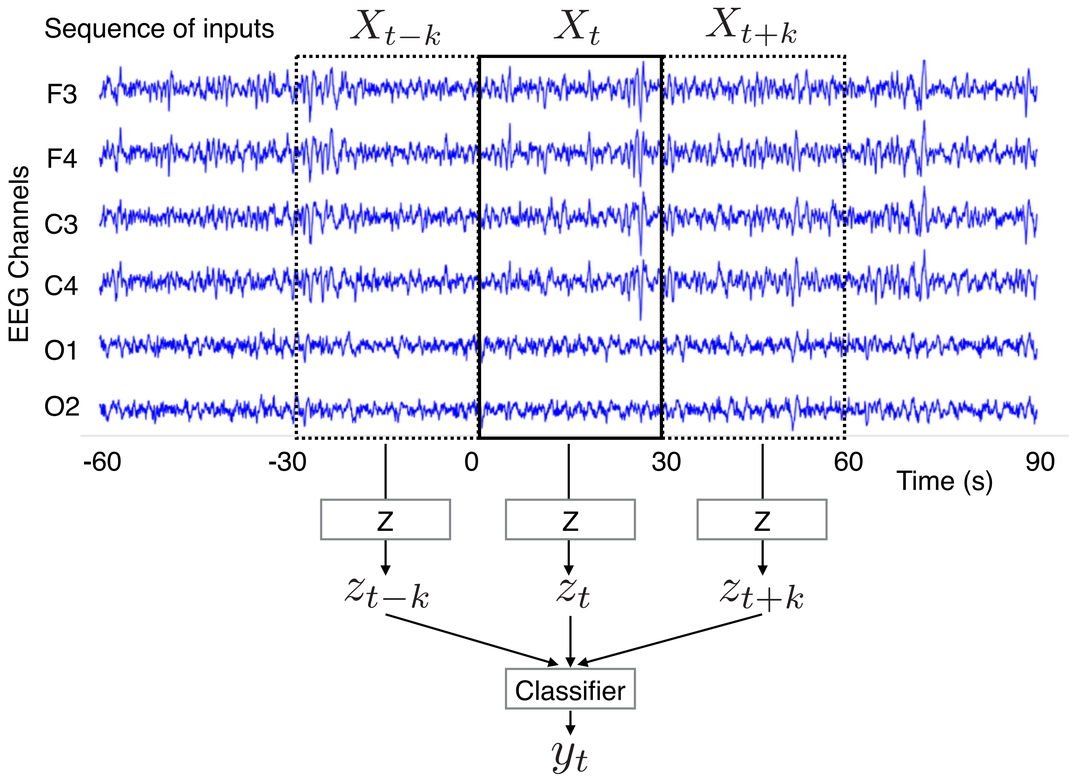
Objective: learn a model $\hat{f} : (\mathbb{R}^{C \times T})^{2k+1} \longrightarrow \mathcal{Y}$ that predicts $\hat{y}_t \in \mathcal{Y}$ given an input ordered sequence $\mathcal{S}_t^k = \{X_{t-k}, \cdots, X_t, \cdots, X_{t+k}\}$ of $2k+1$ neighboring segments of signal

Multivariate architecture

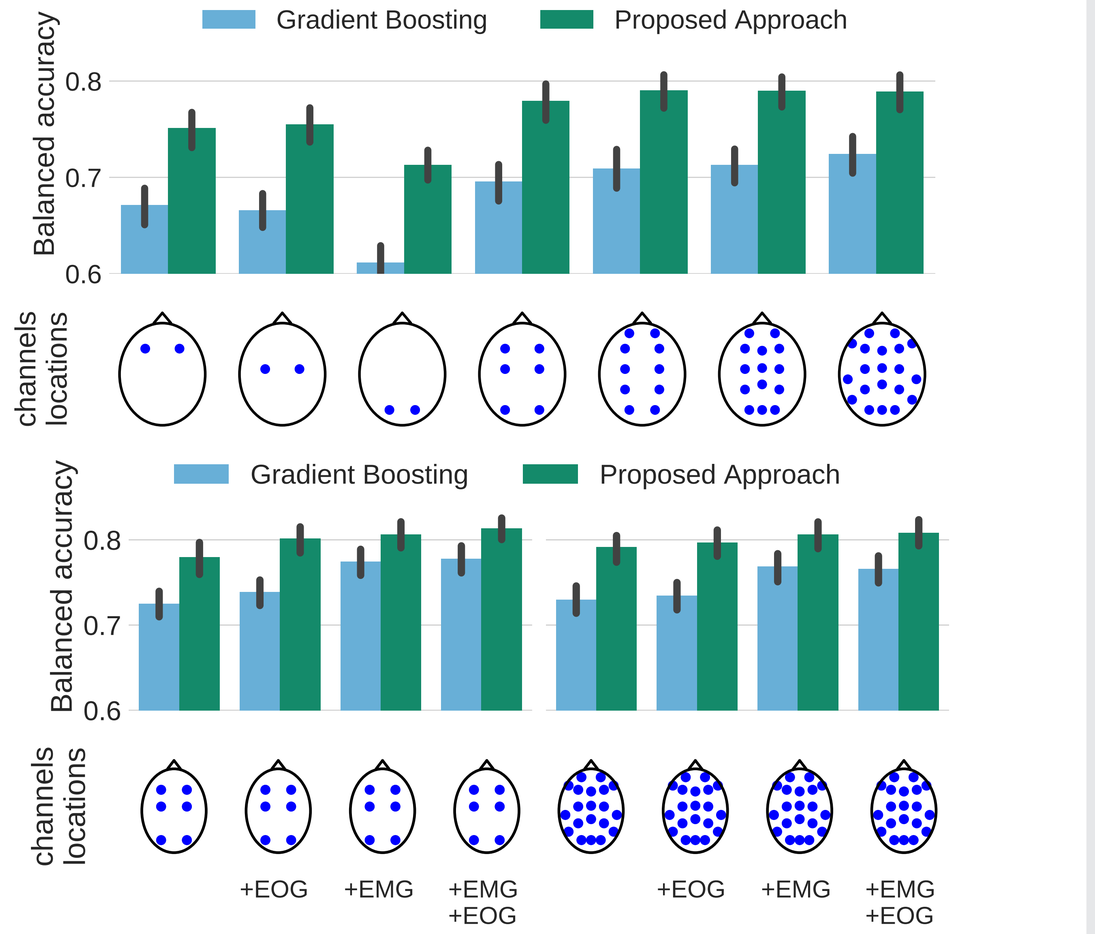
Process EEG/EOG and EMG in similar pipelines



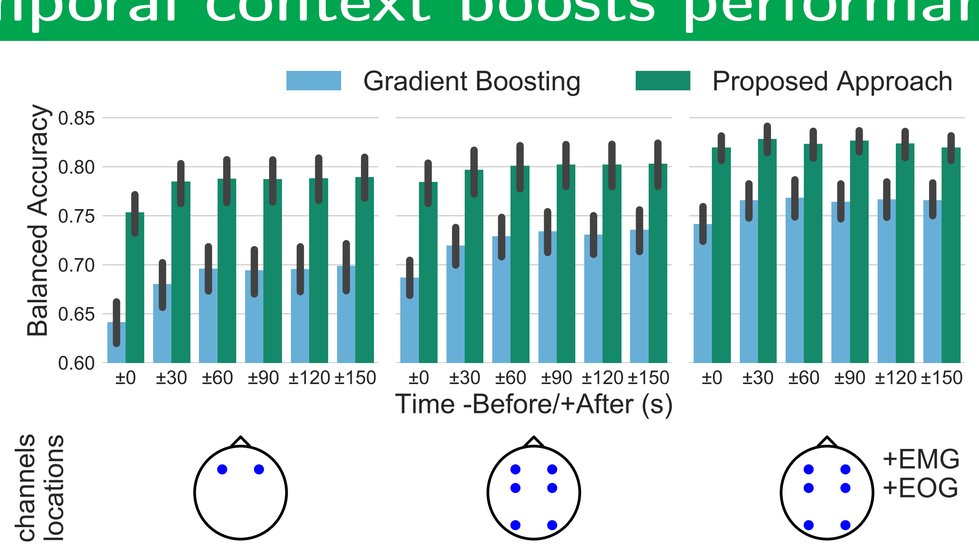
Extract features from neighboring chunks of signals and aggregate them



Spatial context boosts performances

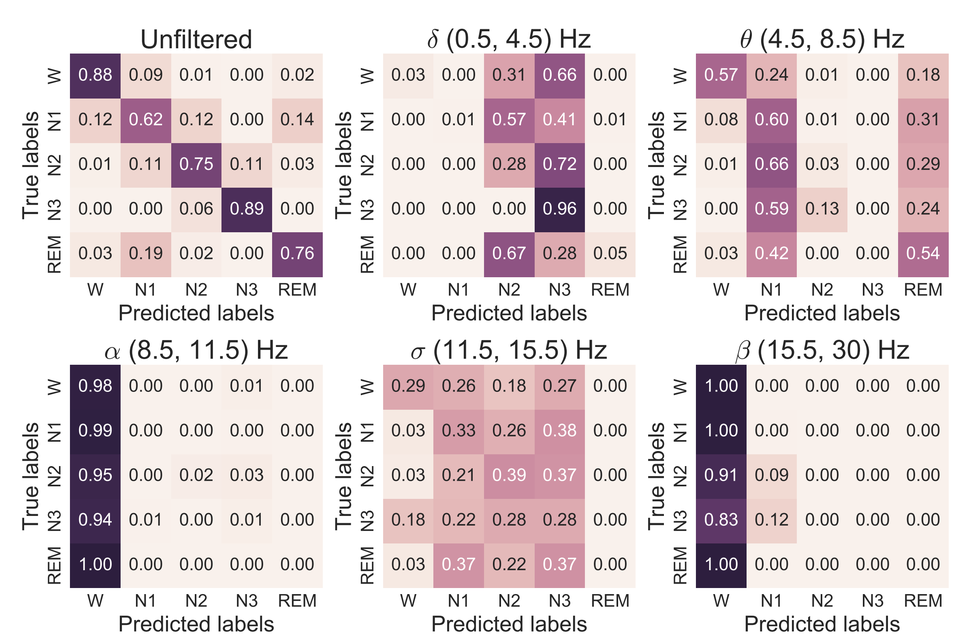


Temporal context boosts performances



Opening the model box

Recover the frequency bands associated to each stage by sleep experts.



References

[1] Chambon, S. Galtier, M., Arnal, P., Wainrib, G., Gramfort, A., A deep learning architecture for temporal sleep stage classification using multivariate and multimodal time series. ArXiv Preprint July 2017.