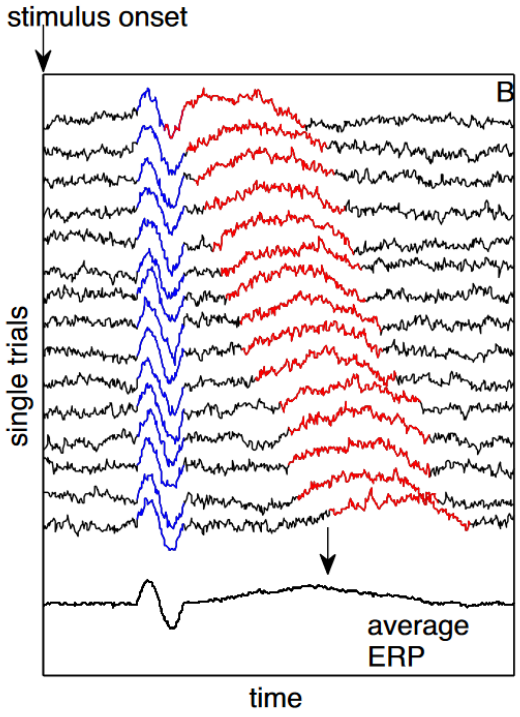
Master's Thesis: Implement the RIDE algorithm into the Unfold.jl toolbox

Description

Conventionally, event-related brain potentials (ERPs) are obtained by averaging several single trials. However, it is reasonable to assume that ERPs are composed of different components, which exhibit trial-to-trial latency variability (see red component in the picture). This would make single-trial averaging problematic, as the effect of components with latency jitter would get "smeared out" in time leading to potential false results.



Residue iteration decomposition (RIDE) is an algorithm developed to decompose ERPs into component clusters with different latency variability and to re-synchronize the separated components into a reconstructed ERP, thus addressing the above-mentioned problem.

Critically, RIDE involves an iterative step to estimate the desired component clusters, which functions as a bottleneck in the pipeline. In this project, we want to implement RIDE into the Unfold.jl toolbox ecosystem and additionally replace this iterative estimation with one unfold-style fit. Thus, we will be able to improve RIDE in two ways: First, through a Julia implementation we will improve the runtime compared to the current Matlab implementation. Second, by replacing the iterative estimation with a single estimation step, we will be able to include covariates into the fit, adjusting for other experimental factors.

Mandatory goals:

- Implement RIDE into the Unfold.jl toolbox while replacing the iterative component estimation with one unfold fit
- Testing of Unfold-RIDE using custom simulations

Stretch goals:

- Allow RIDE to estimate covariates alongside the three components
- Apply RIDE-Unfold to a real dataset

Requirements:

- Matlab, Python and/ or Julia experience will be necessary
- Statistics and EEG experience will be helpful but not necessary

The project will be jointly supervised by René Skukies and Benedikt Ehinger (CCS/VIS)

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