BR41N.IO

THE BRAIN-COMPUTER INTERFACE
## DESIGNERS HACKATHON

BR41N.IO

"RehabRiem": Stroke Rehabilitation Data Analysis using Riemannian Manifolds

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Introduction

- Stroke Rehabilitation dataset
  - Sampling Frequency: 256 Hz
  - 16 EEG Electrodes
  - 2 Tasks
    - 1 -> Left hand
    - -1 -> Right hand
  - Pre and post treatment recordings

- Data Dimensions :
  Raw-(~21000,16)
  Segmented-(80, 1536, 16)

- State-of-the-art MI-EEG classifier
  - CSP+LDA- 81.60%
  - PCA+TVLDA- 92.22%
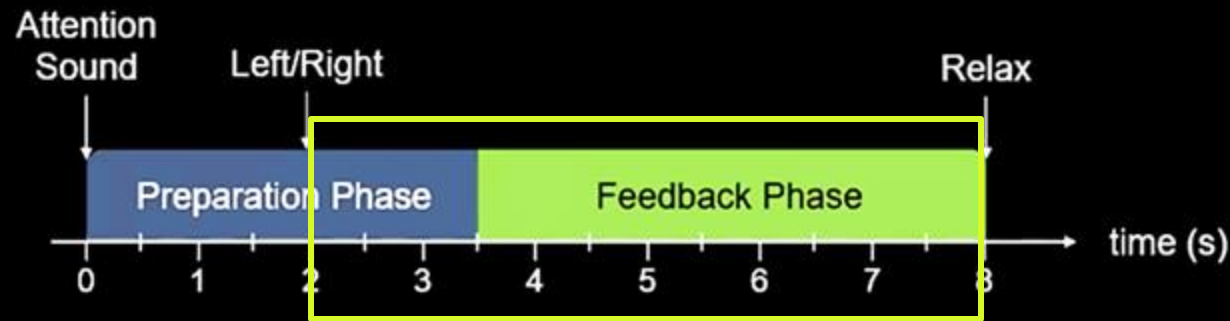
Our goals:
- Explore **new features** to improve classification
- Draw **physiologically-meaningful insights**

Proposed Framework
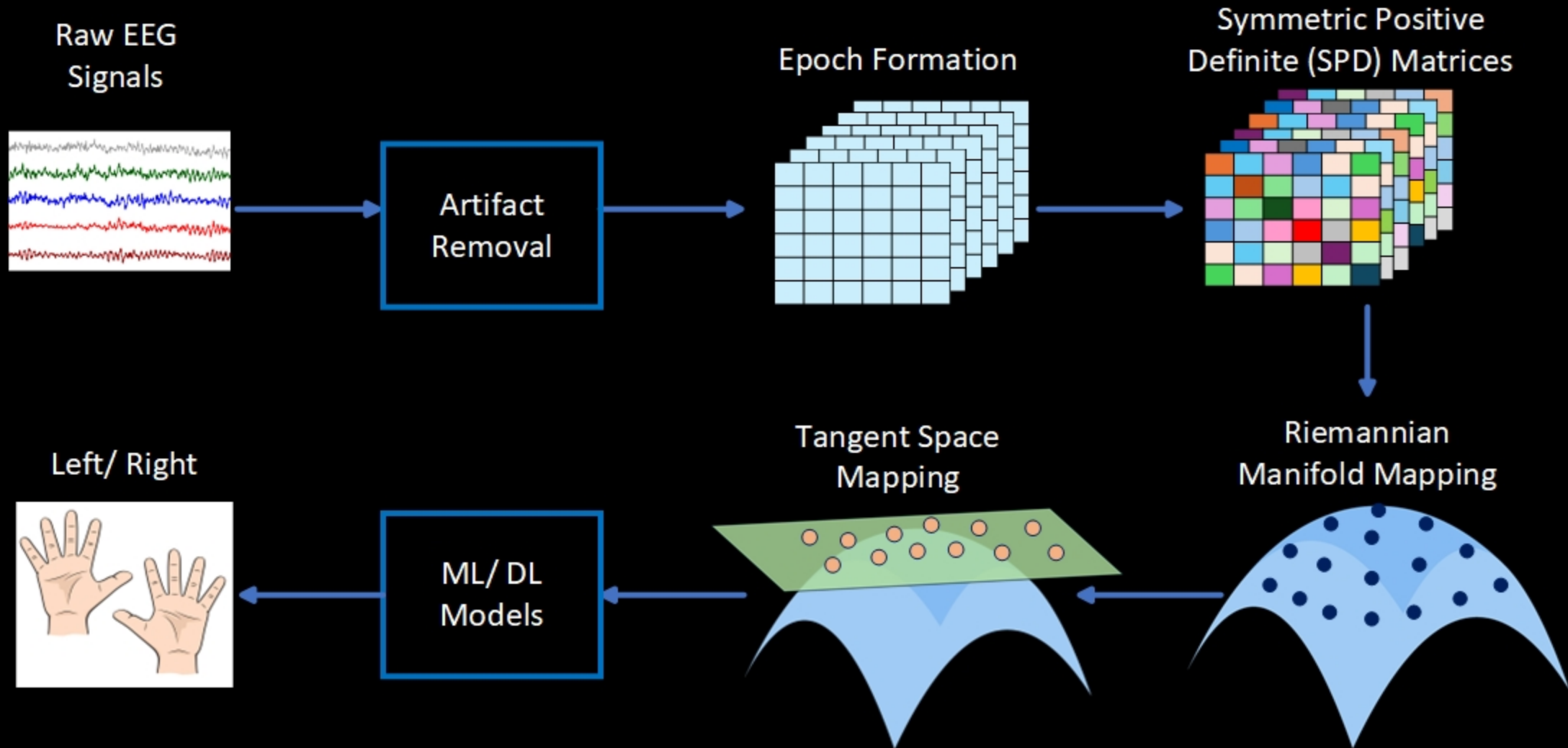
Implementation

Preprocessing:

Bandpass filter (8- 30 Hz)

Z-score Normalization

Segmentation (6 secs)

Feature Extraction Methods:
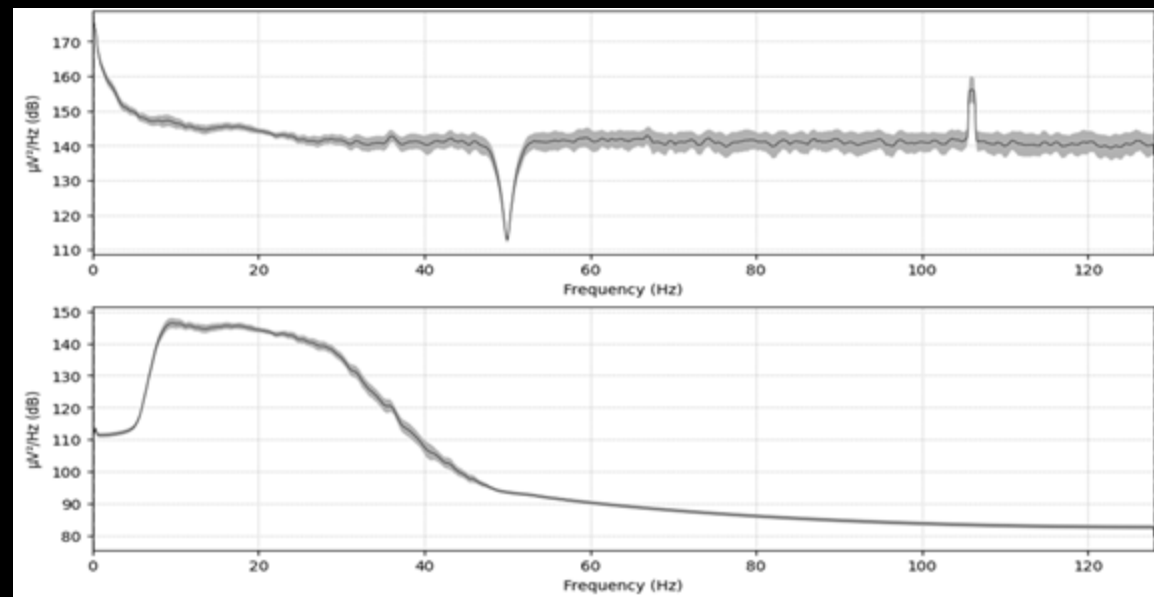
Riemannian SPD matrices- (80,16,16)
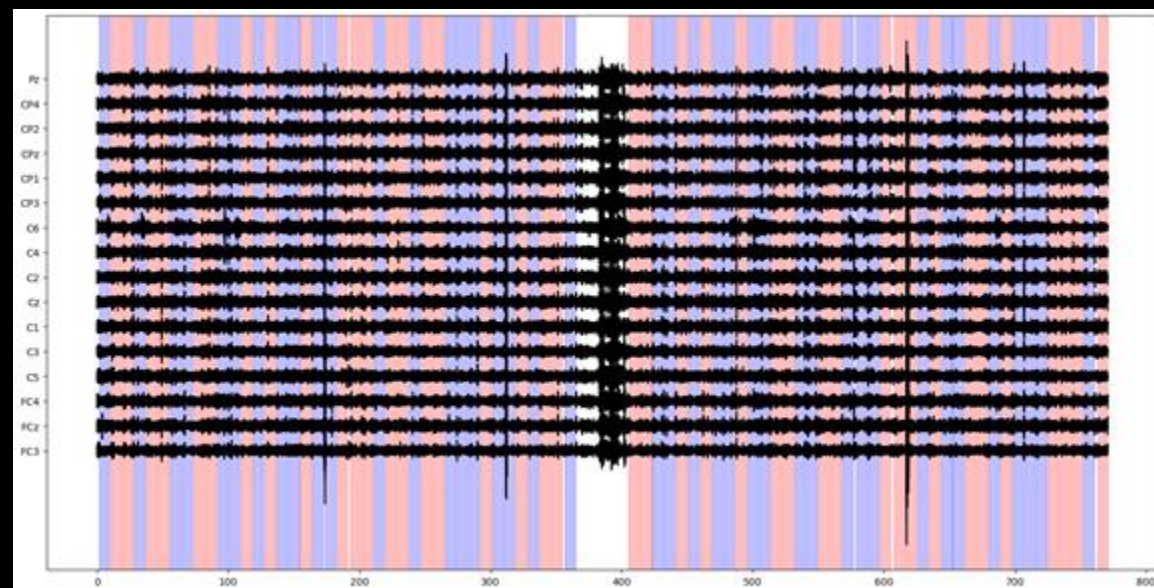
Tangent Space Vectors-(80,136,1)

ML/DL models:

LDA, Random Forest, NN

PSD plots

Before After

EEG time series

Trigger referencing

Results

| Subject	Stage	Purpose	File Name	Riemannian+LDA		Riemannian+RF		Riemannian+NN	
				Validation	Test	Validation	Test	Validation	Test
P1	pre	training	P1_pre_training.mat	82.50%	78.25%	91.25%	84.36%	96.25%	94.82%
		test	P1_pre_test.mat						
	post	training	P1_post_training.mat	80.00%	86.25%	85.00%	86.25%	93.75%	91.25%
		test	P1_post_test.mat						
P2	pre	training	P2_pre_training.mat	71.25%	78.75%	72.50%	77.50%	98.45%	92.67%
		test	P2_pre_test.mat						
	post	training	P2_post_training.mat	78.74%	76.25%	80.00%	77.97%	89.76%	100.00%
		test	P2_post_test.mat						
P3	pre	training	P3_pre_training.mat	83.95%	86.25%	86.25%	95.00%	100.00%	93.75%
		test	P3_pre_test.mat						
	post	training	P3_post_training.mat	89.00%	87.96%	82.85%	85.00%	83.50%	88.00%
		test	P3_post_test.mat						
Average				80.91%	82.29%	82.98%	84.35%	**93.62%**	**93.42%**

(CSP+LDA): 81.6%, (PCA+TVLDA): 92.22%, (Riemannian+NN): 93.42%

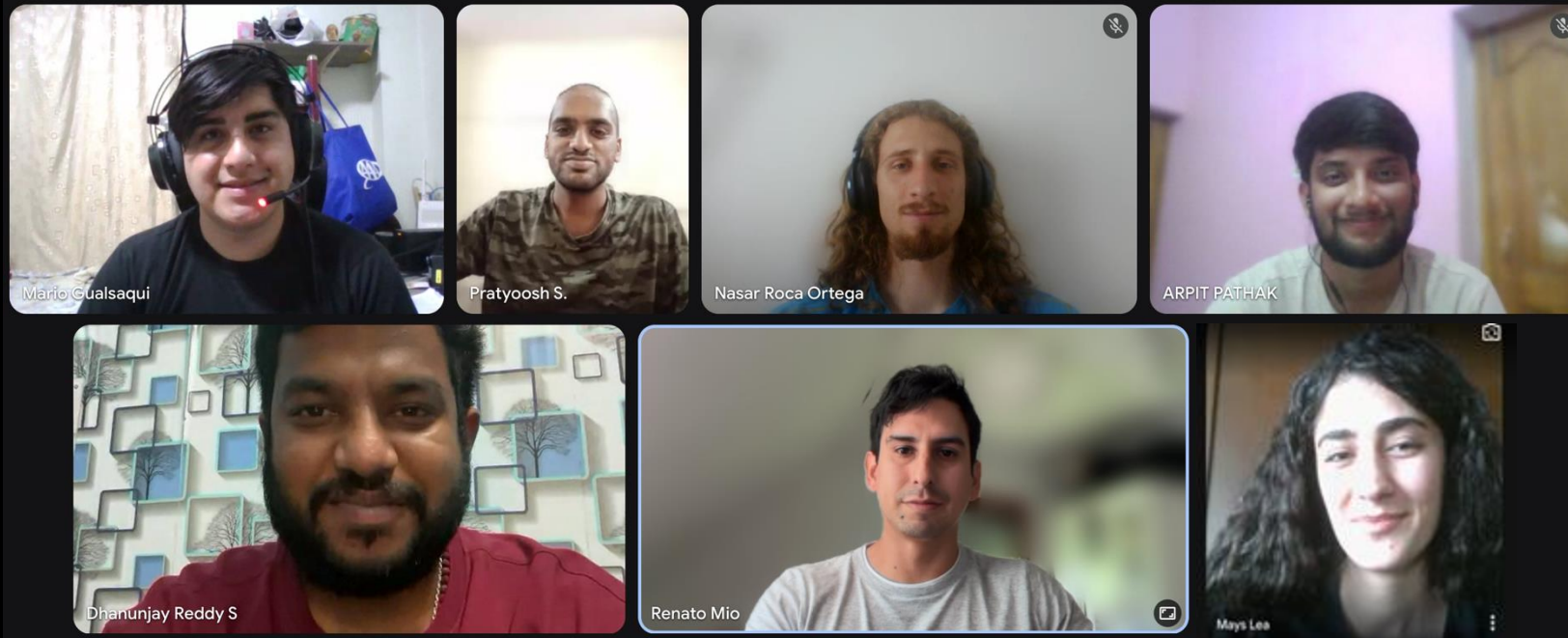→ Our proposed Riemannian feature-based framework performed with a +1.2% gain in comparison with state-of-the-art.

Observation – Feature importance

Electrodes importance in a classification model using SHAP values

Slight change in laterality of electrode importance between pre and post.
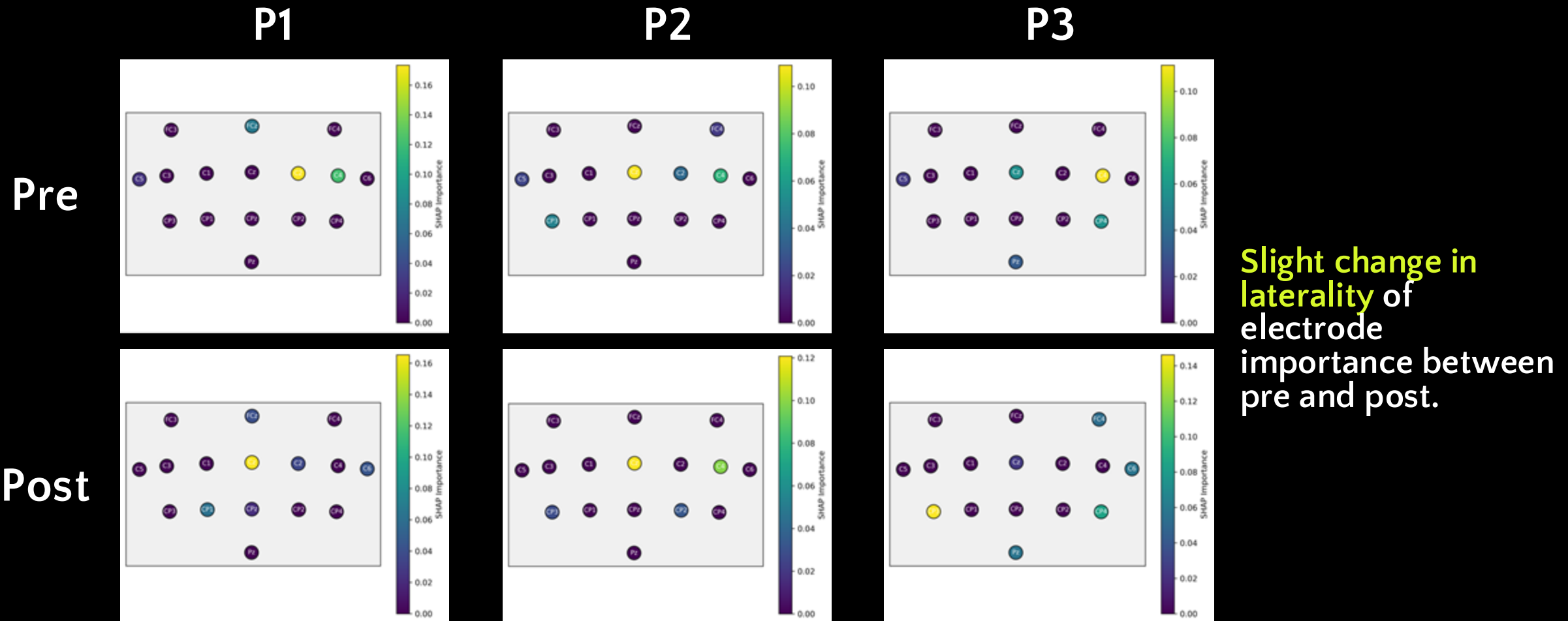
RehabRiem Team

Github Repo

https://github.com/renatomio/br41n_io_hackaton-stroke-rehab