

BR41N.10

THE BRAIN-COMPUTER INTERFACE DESIGNERS HACKATHON



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"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
 - o CSP+LDA- 81.60%
 - PCA+TVLDA- 92.22%

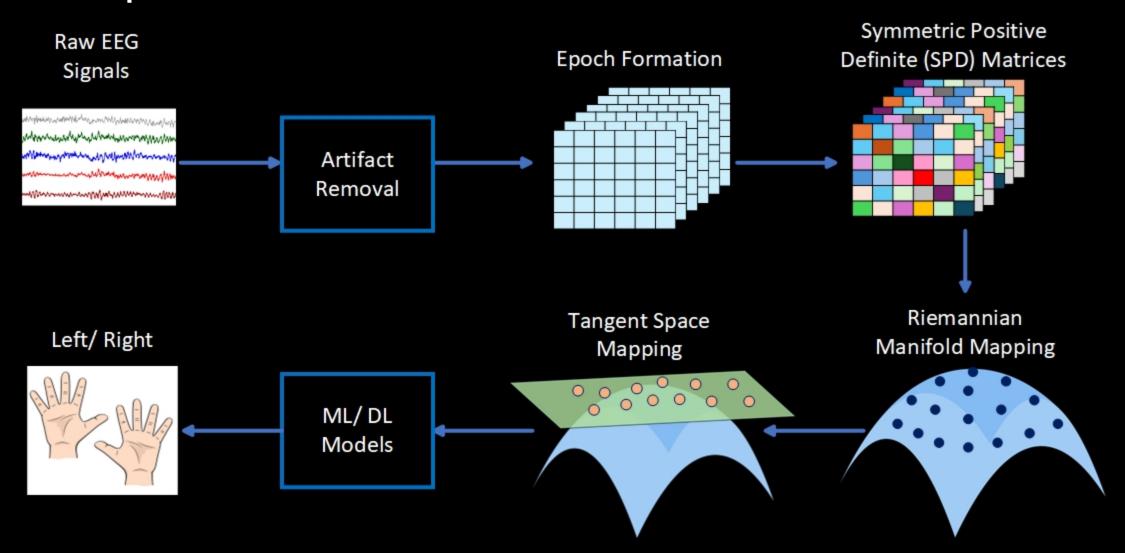


Our goals:

- Explore new features to improve classification
- Draw physiologically-meaningful insights



Proposed Framework



Implementation

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Preprocessing:

Bandpass filter (8-30 Hz)

Z-score Normalization

Segmentation (6 secs)

Feature Extraction Methods:

Riemannian SPD matrices- (80,16,16)

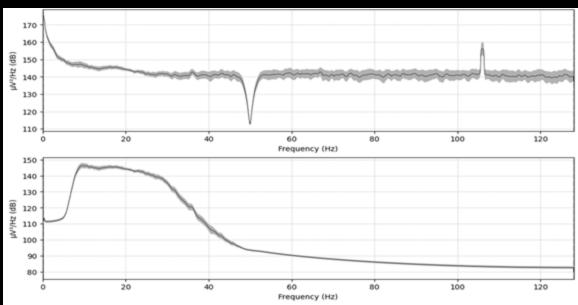
Tangent Space Vectors-(80,136,1)

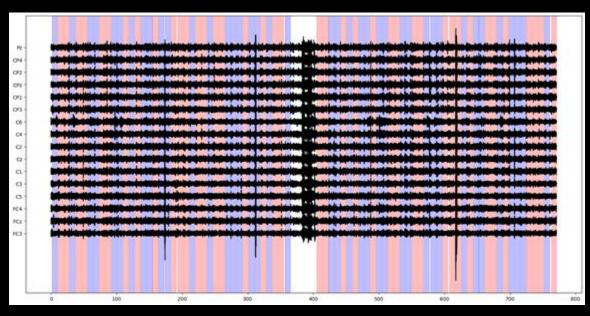
ML/DL models:

LDA, Random Forest, NN



EC time series





Before

Afte

Trigger referencing

Results



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

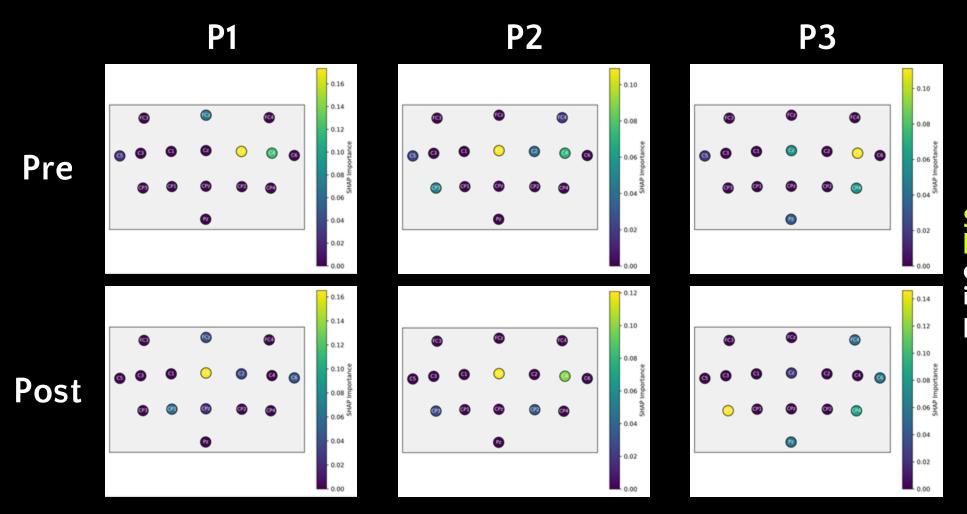
(CSP+LDA): 81.6%, (PCA+TVLDA): 92.22%, (Riemannian+NN): 93.42%

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

Observation – Feature importance



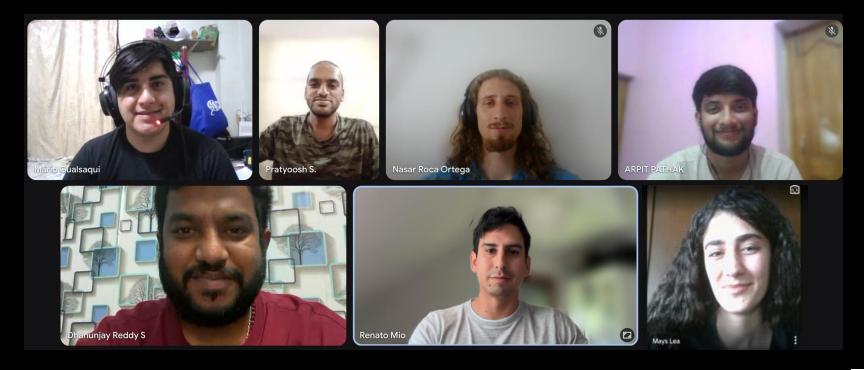
Electrodes importance in a classification model using SHAP values



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



RehabRiem Team



Github Repo

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

