



Image Credit:
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Analyse des performances du Transfer Learning avec différentes bases de données EEG.

Analyzing the performance of transfer learning with different EEG datasets

- Ronnie Liu
- Anas Bourhim
- Hichem Sahraoui
- Van Nam Vu

Presentation outline

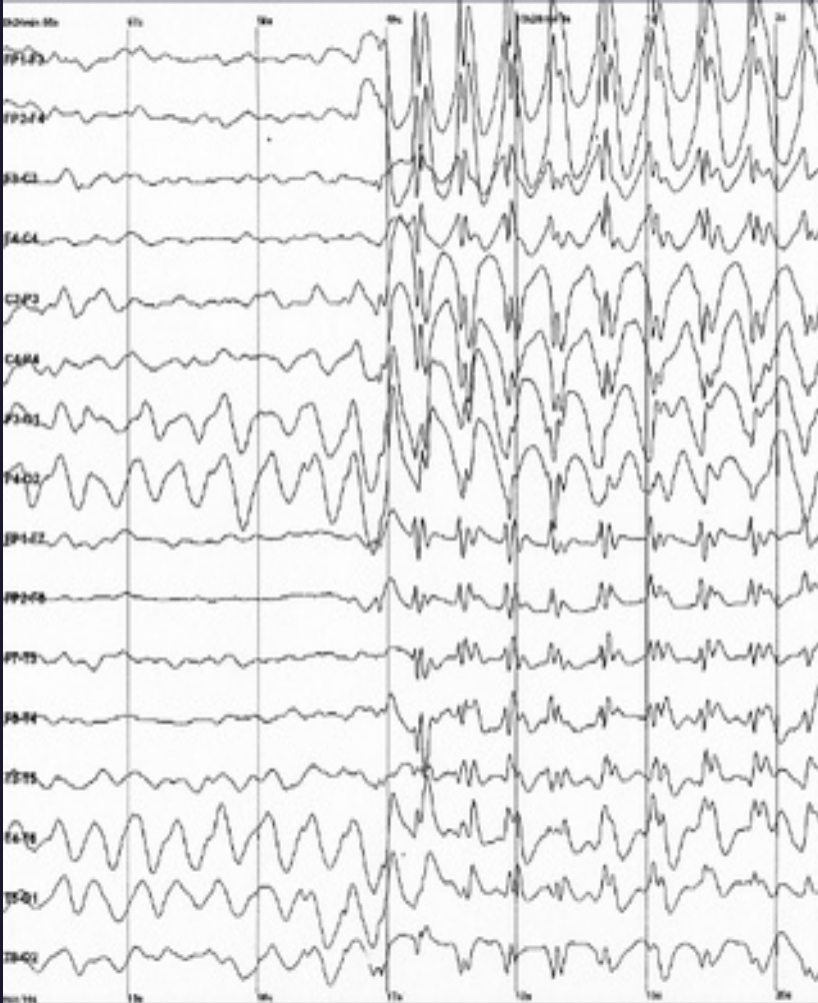
- I. GOALS AND MOTIVATION
- II. FUNDAMENTALS OF EEG
- III. DATASETS
- IV. METHODS
- V. RESULTS AND ANALYSIS
- VI. EXTENDABILITY



I. GOALS AND MOTIVATION

- Being able to preprocess and extract essential features for different EEG datasets
- Further our understanding of transfer learning with different EEG datasets
- Compare the accuracy of the dataset of meditation -thinking between different methods (data training from scratch vs transfer learning)

II. What is EEG ?

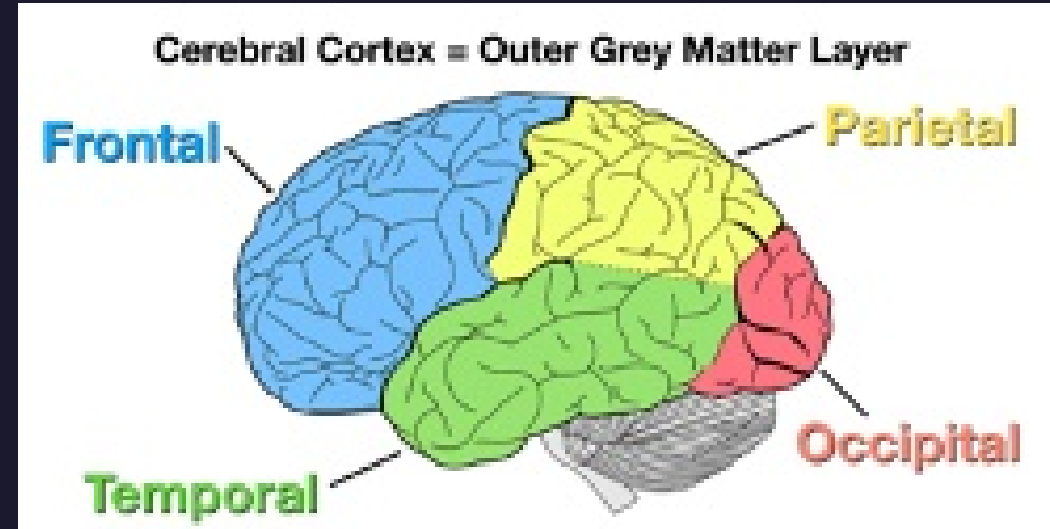
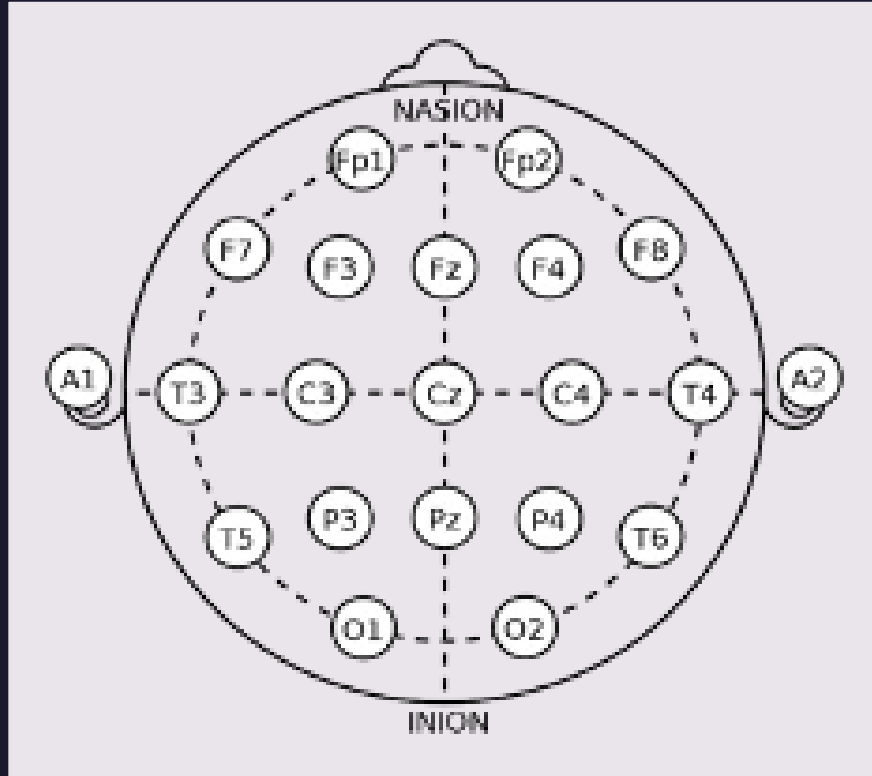


CREDIT: UNSPLASH.COM (FREE)

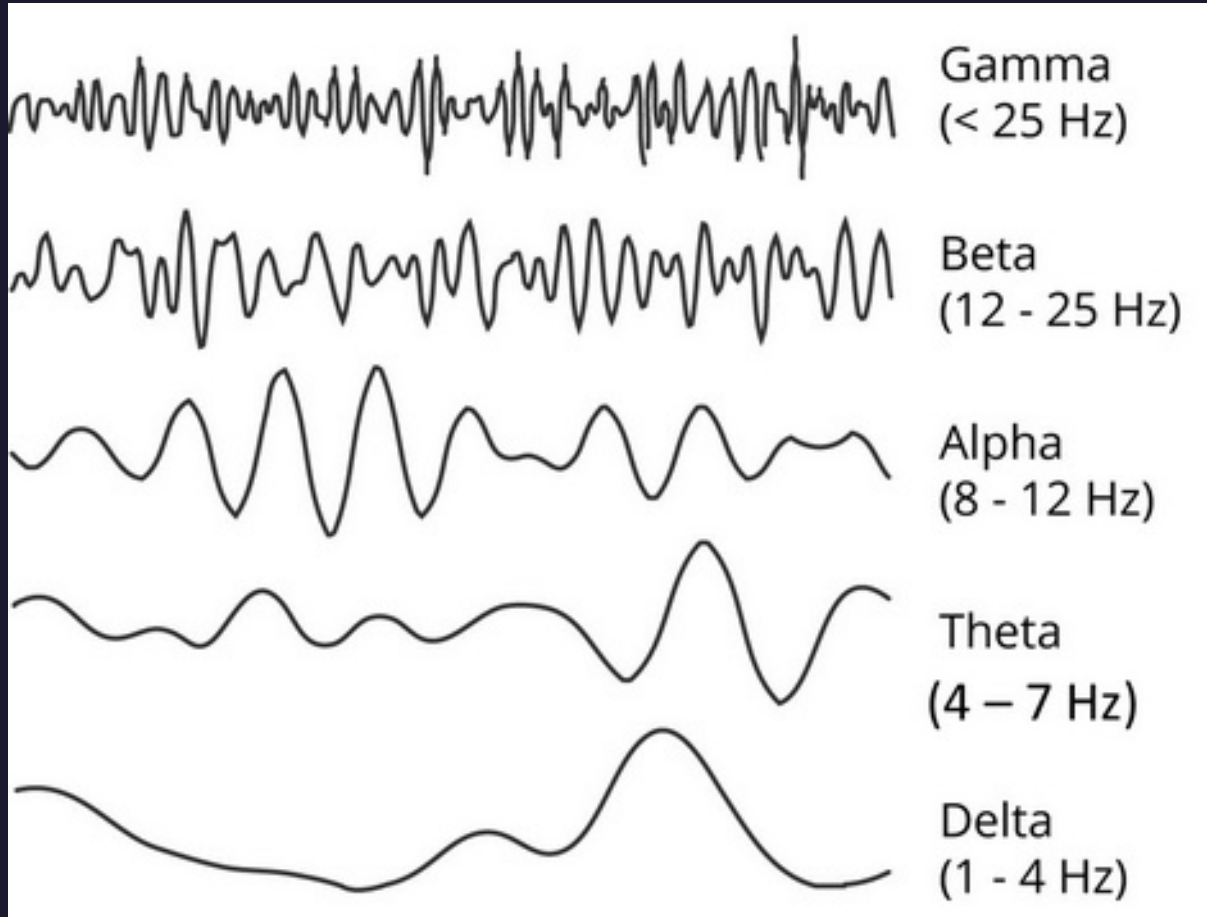
- Abbreviation for Electroencephalography
- A method to record the electrical activity of the brain from the scalp
- By a EEG cap



II. What is EEG ?



II. What is EEG ?



Motor Functions, higher mental



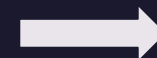
Normal waking state, concentration, focus, five physical sense



Relaxed, light meditation, creative, super learning, consciousness



Light sleep, deep meditation



Deep, dreamless sleep, unconscious

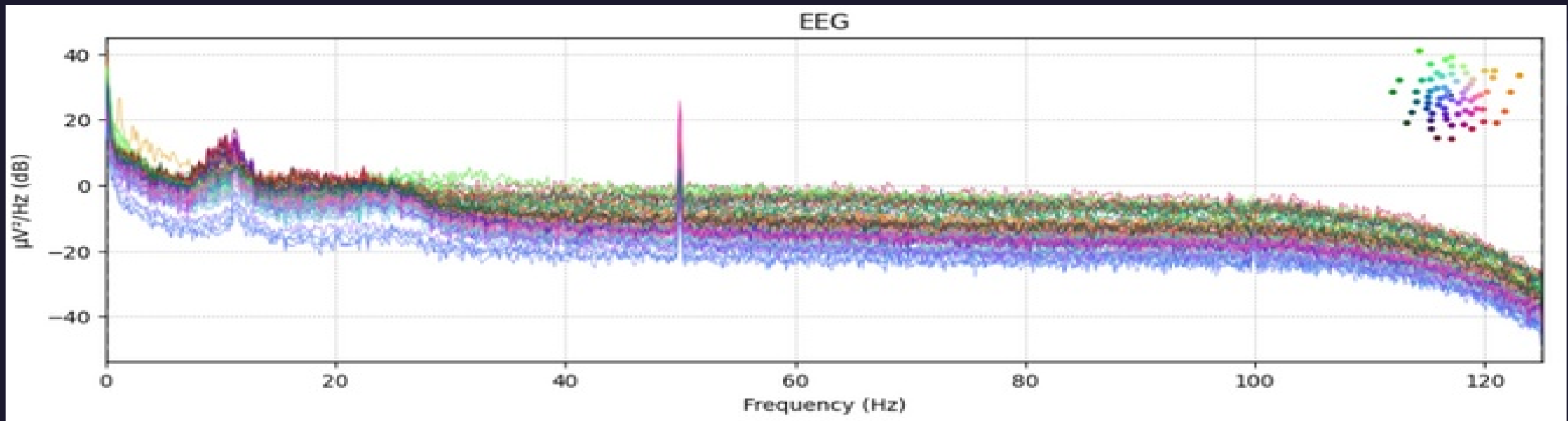
III. EEG Music listening



CREDIT: UNSPLASH.COM (FREE)

<https://openneuro.org/datasets/ds003774/versions/1.0.0>

- 20 participants
- Each close their eyes and listen 12 songs of different genres
- Record with 129 electrodes
- Rate the enjoyment 1 (most) to 5 (least)
- Binary Classification :
 - rate 1 to 3 : class 1 (enjoyment)
 - rate 4 to 5 : class 0 (not enjoyment)



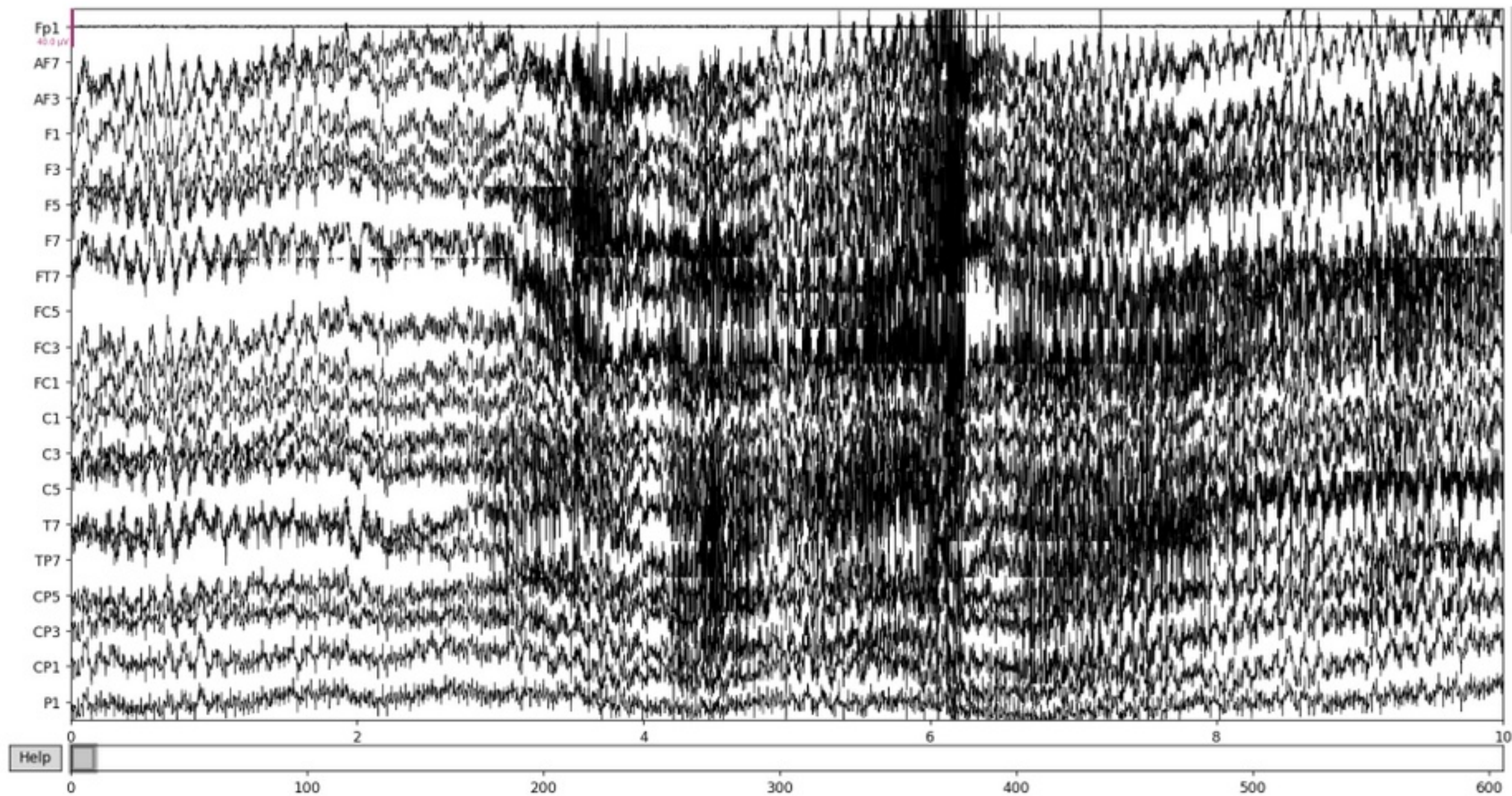
III. EEG Meditation vs Thinking

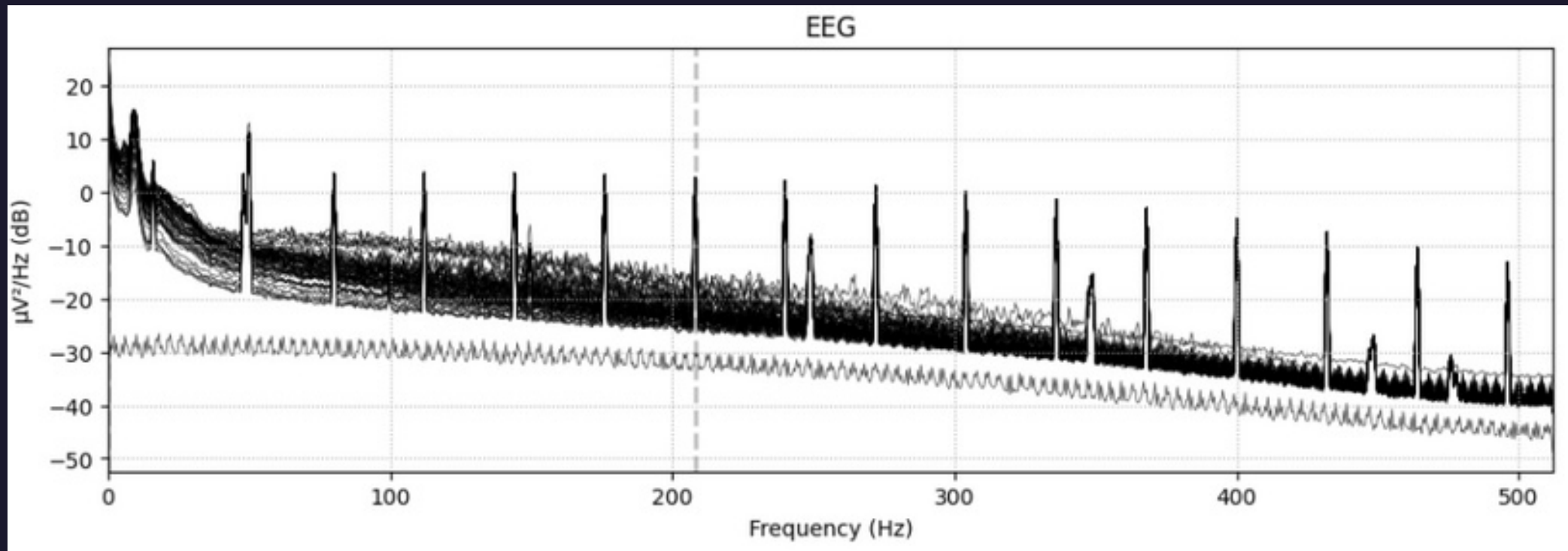
<https://openneuro.org/datasets/ds003969/versions/1.0.0>

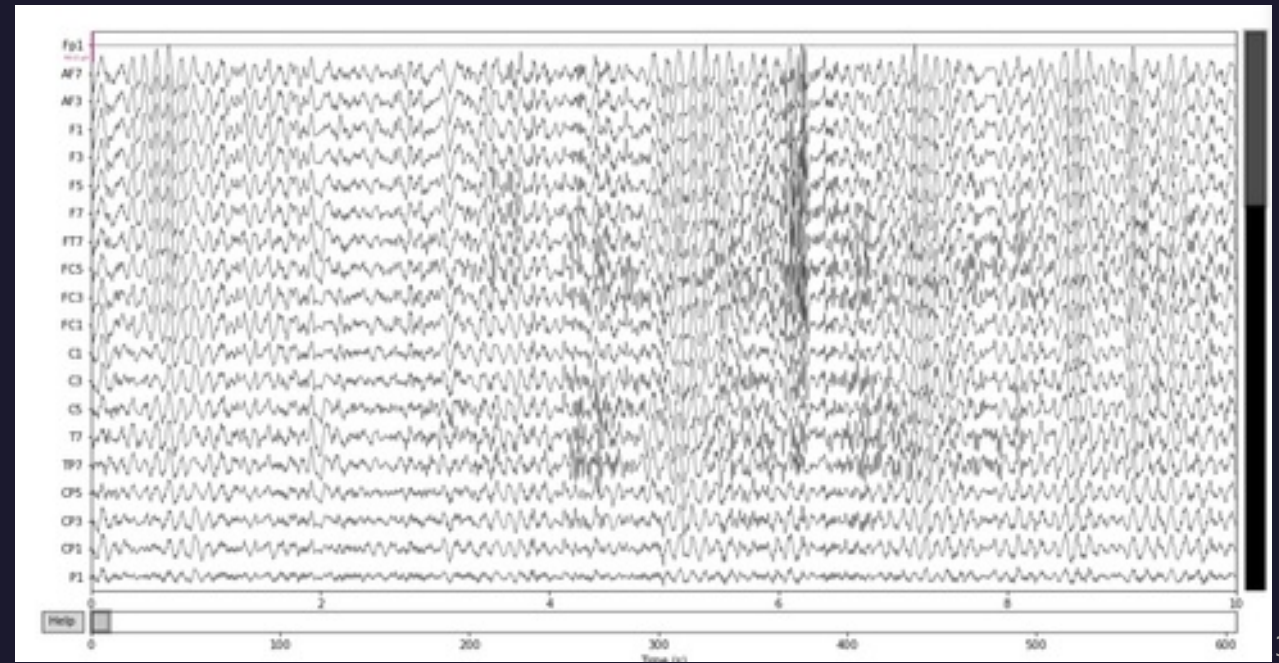
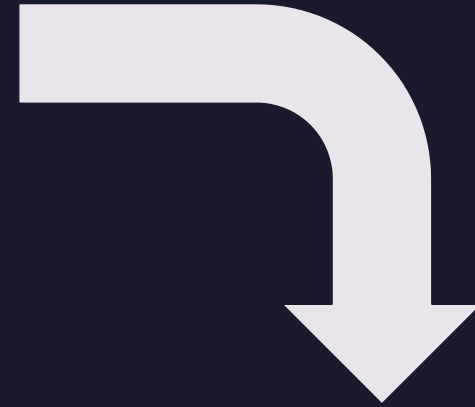
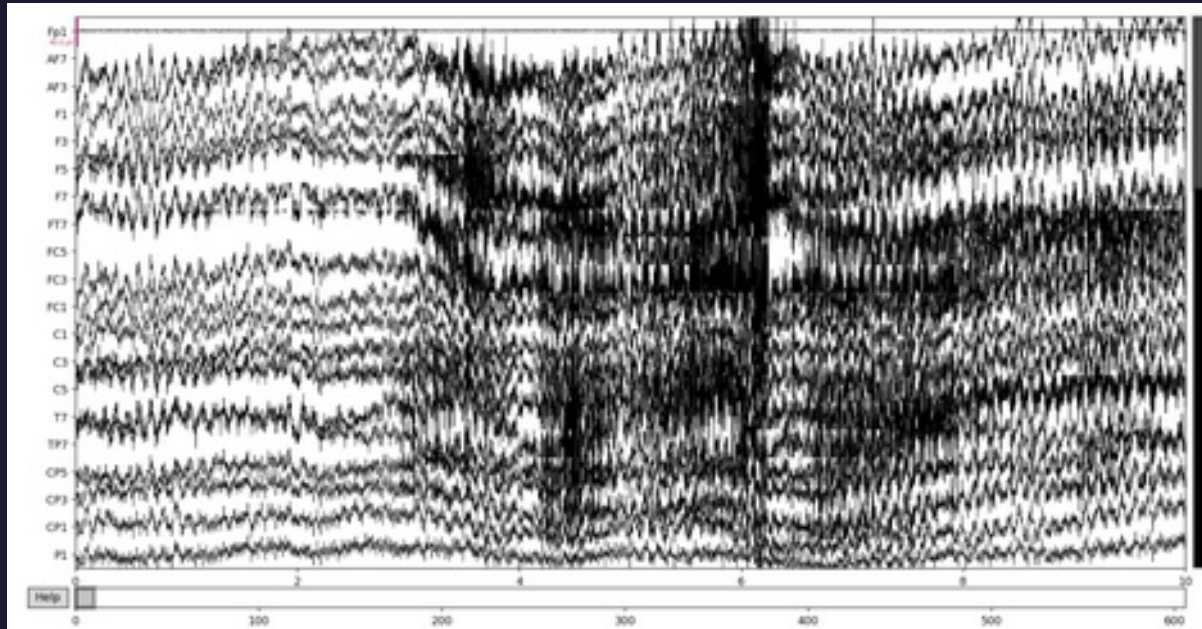
- 98 participants
- Performed 4 blocks of 10 minutes:
 - Thinking block
 - Meditation block : breath counting
 - Thinking block
 - Meditation block : tradition-specific meditation
- Record with 74 - 82 electrodes
- Binary Classification :
 - Meditation : class 1
 - Thinking : class 0

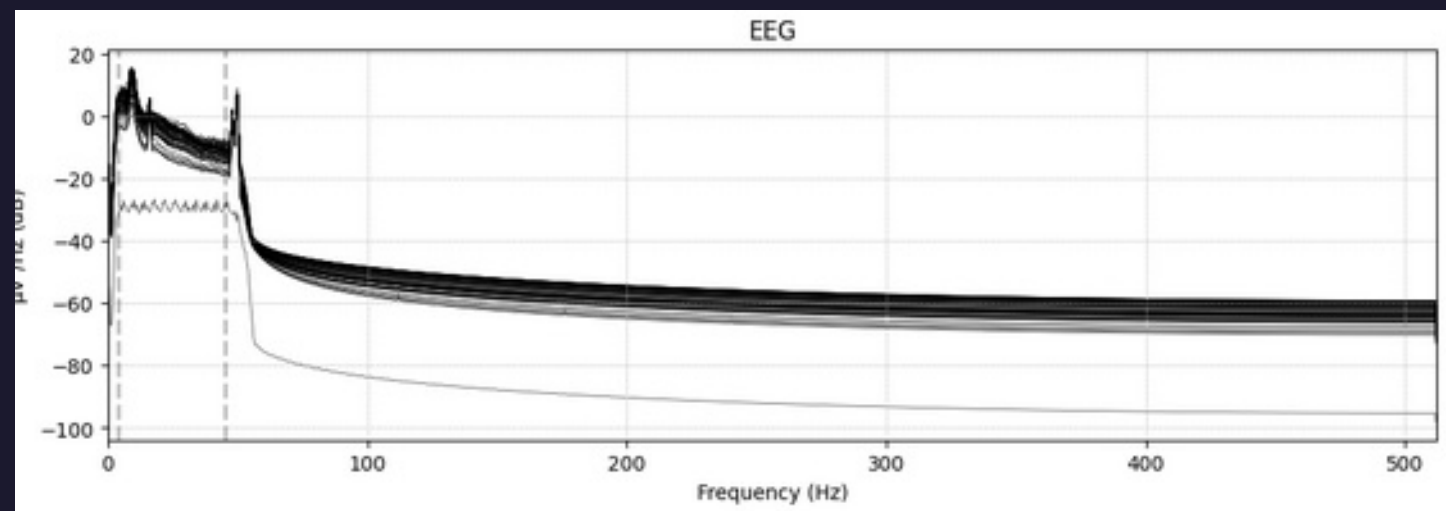
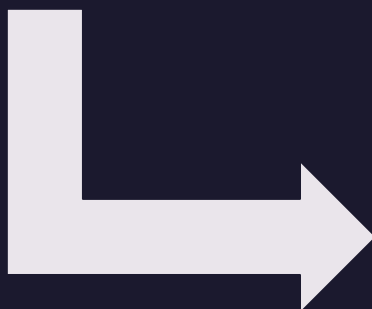
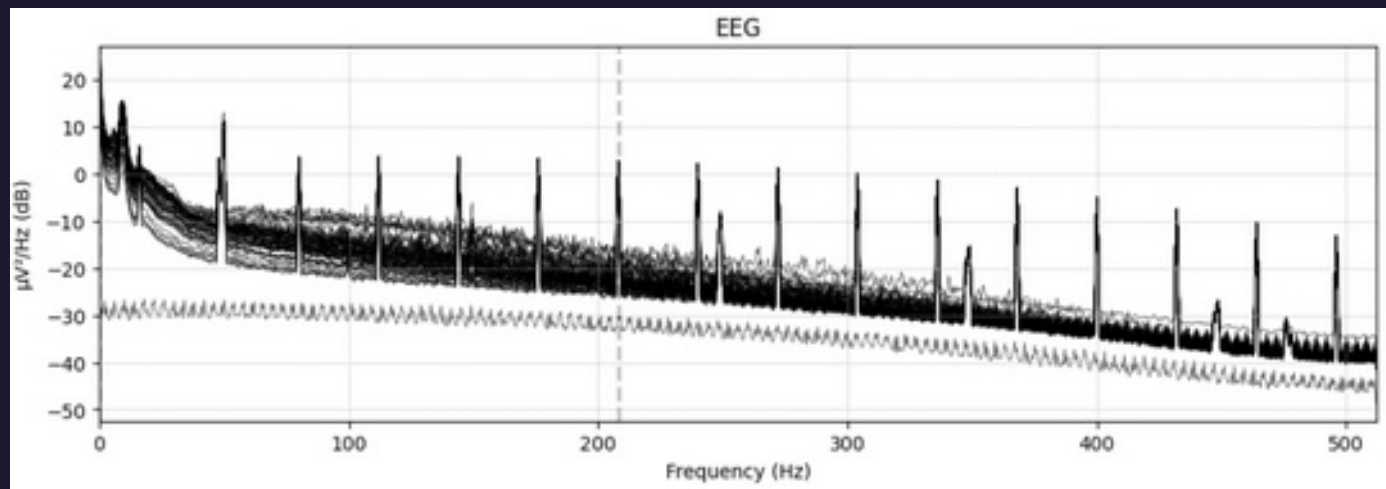


CREDIT: UNSPLASH.COM (FREE)





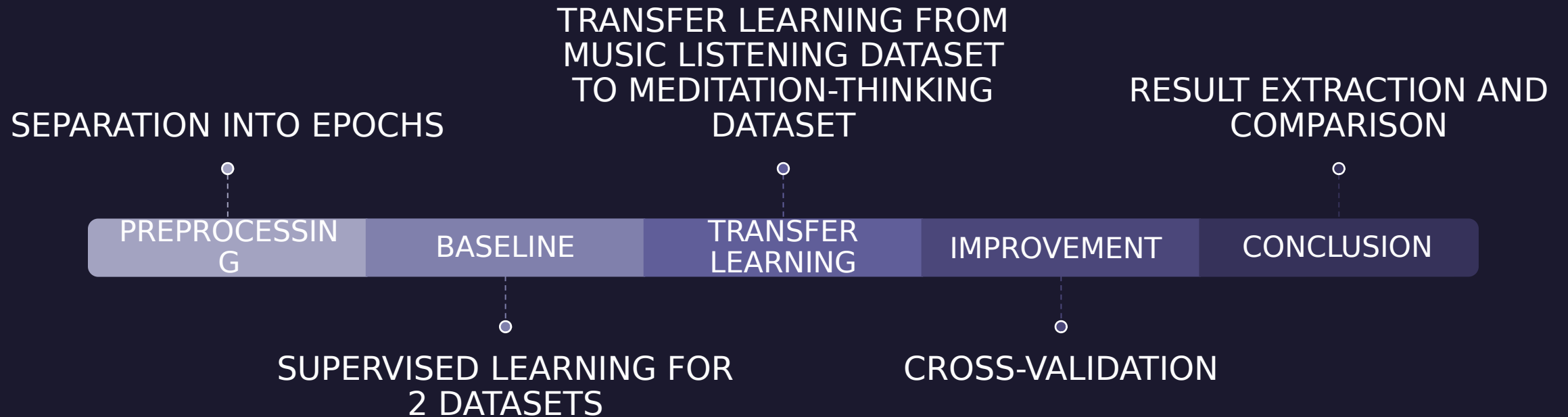




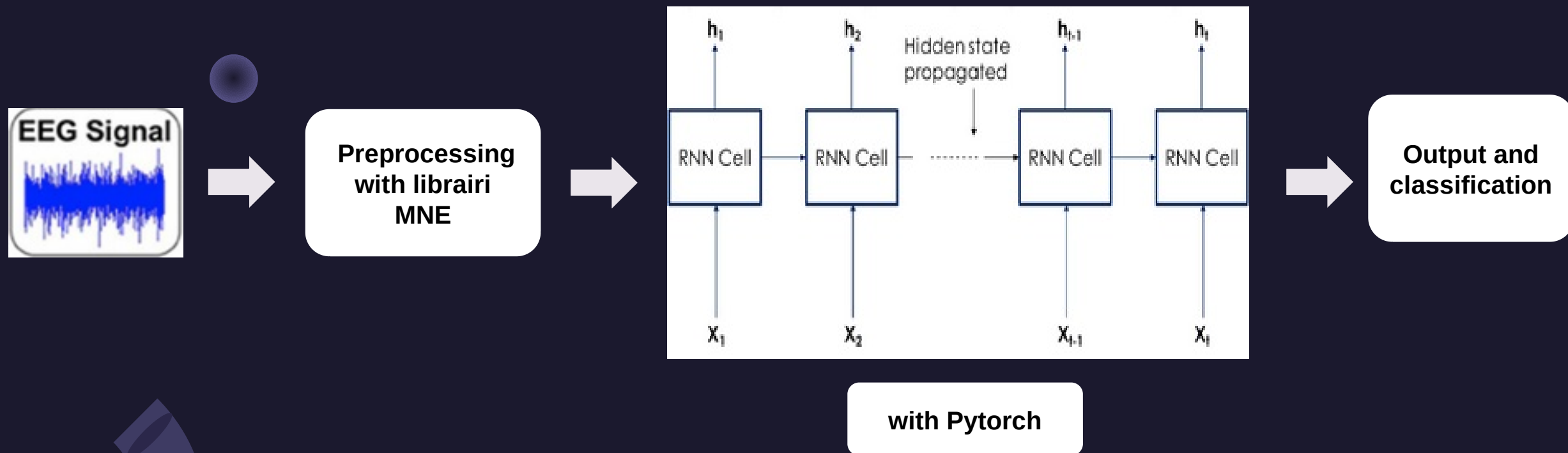


For information, due to time and memory issues, we only use a part of each dataset to build model :(

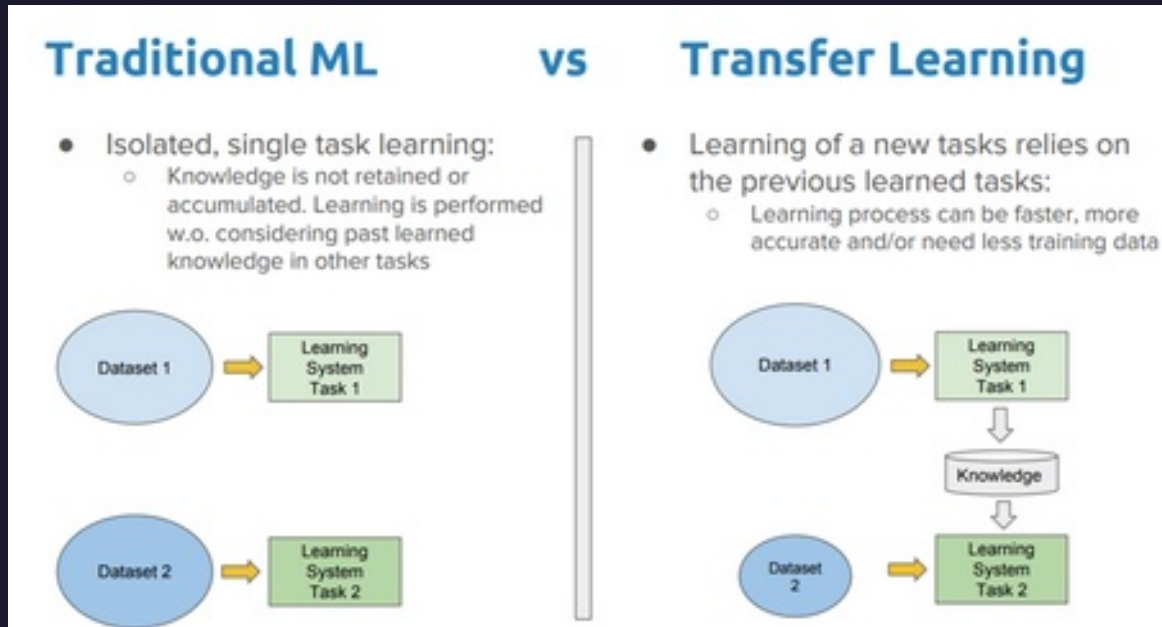
IV. METHODS



WORKFLOW RNN



TRANSFER LEARNING



- Solution for small dataset, especially EEG datasets
- Multiple type of Transfer Learning :
 - Freeze all the layers
 - Freeze some layers

CREDIT : [HTTPS://TOWARDSDATASCIENCE.COM/A-COMPREHENSIVE-HANDS-ON-GUIDE-TO-TRANSFER-LEARNING-WITH-REAL-WORLD-APPLICATIONS-IN-DEEP-LEARNING-212BF3B2F27A](https://towardsdatascience.com/a-comprehensive-hands-on-guide-to-transfer-learning-with-real-world-applications-in-deep-learning-212bf3b2f27a)

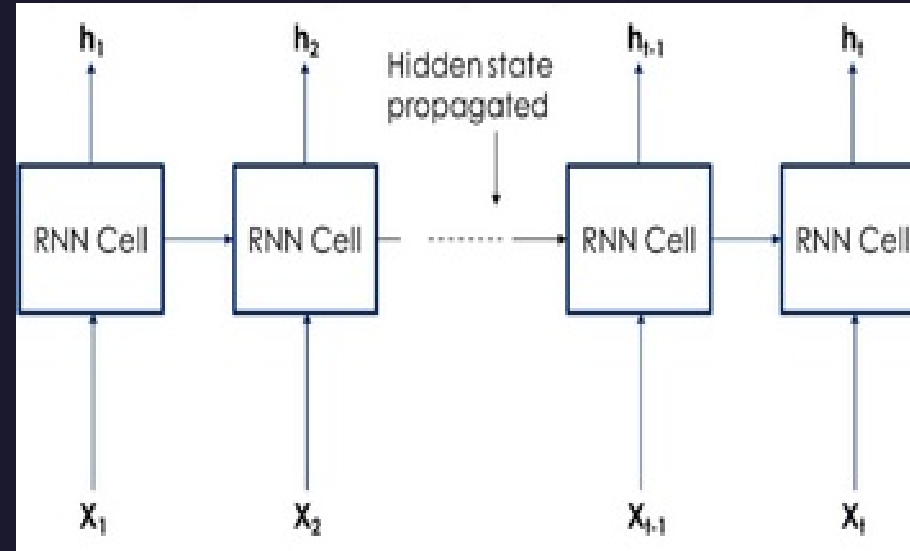
Architecture RNN + transfer learning

Model Music listening
trained with RNN



Meditation
and Thinking

Preprocessing
with librairi
MNE



Output and
classification

1. Freeze all layers

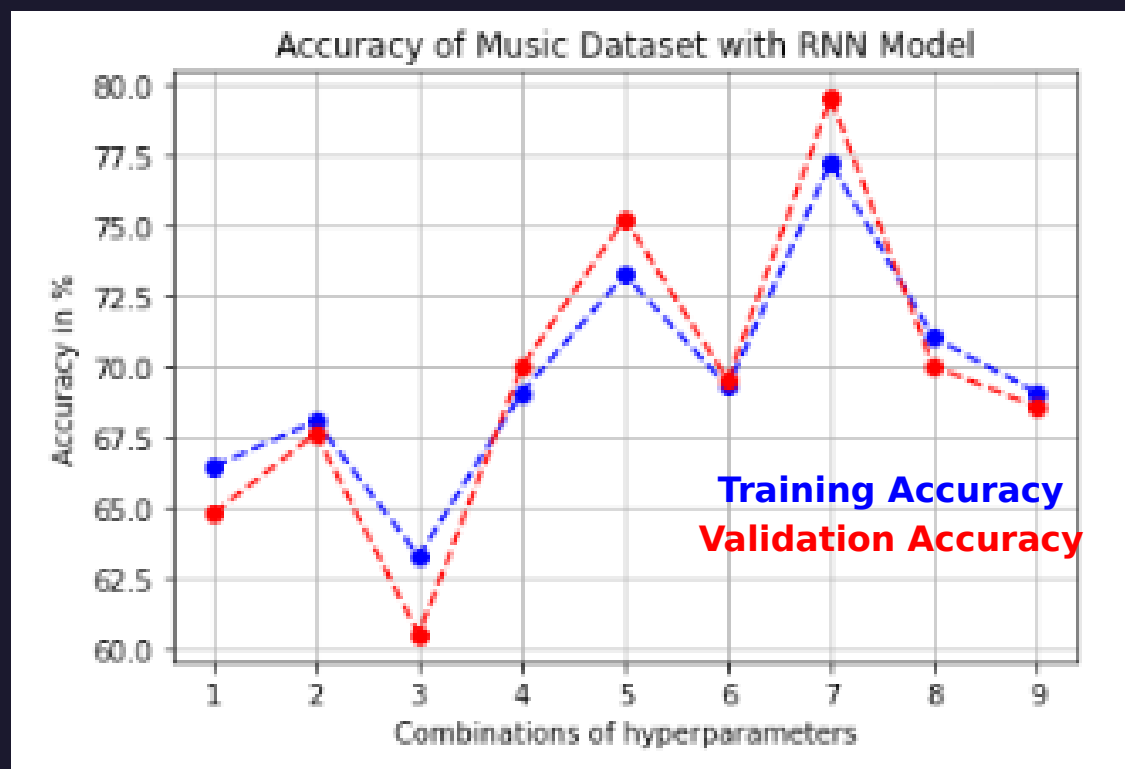
2. Freeze
first layer



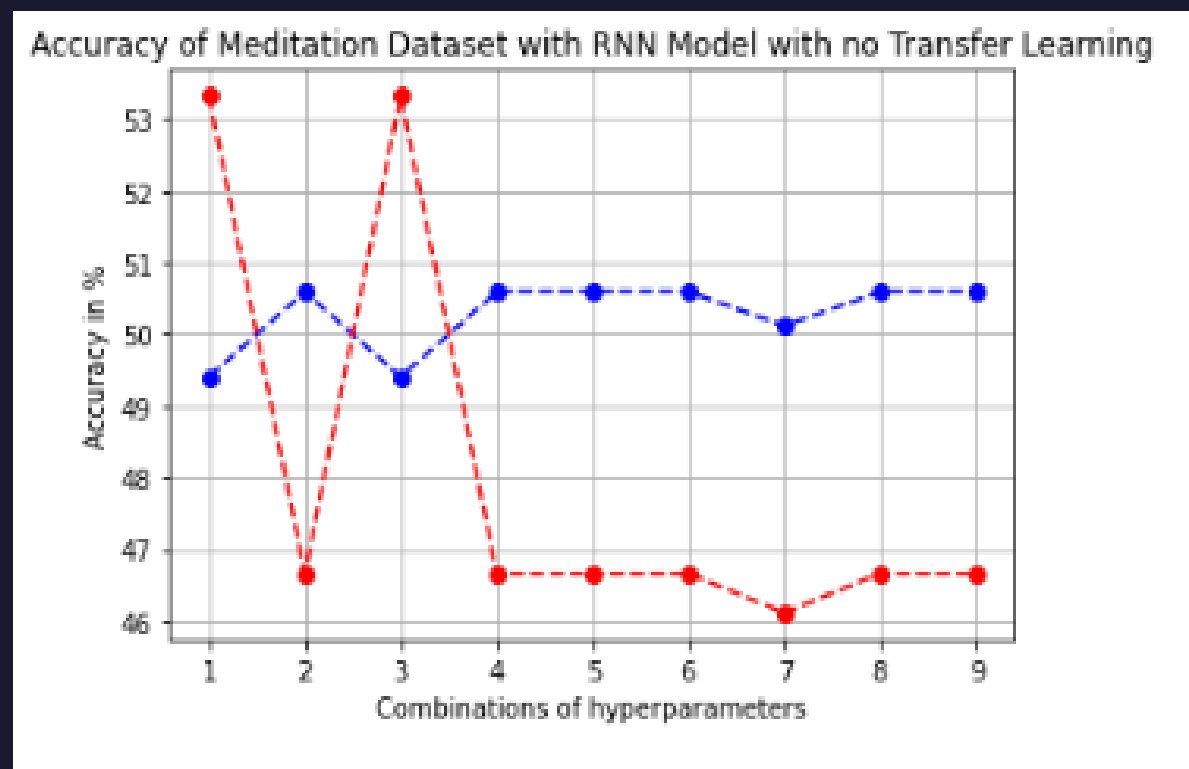
V. RESULTS AND ANALYSIS

BASELINE: RNN MODEL

MUSIC DATASET



MEDITATION DATASET



Combinations of hyperparameters [“number of epochs” - “batch size”]

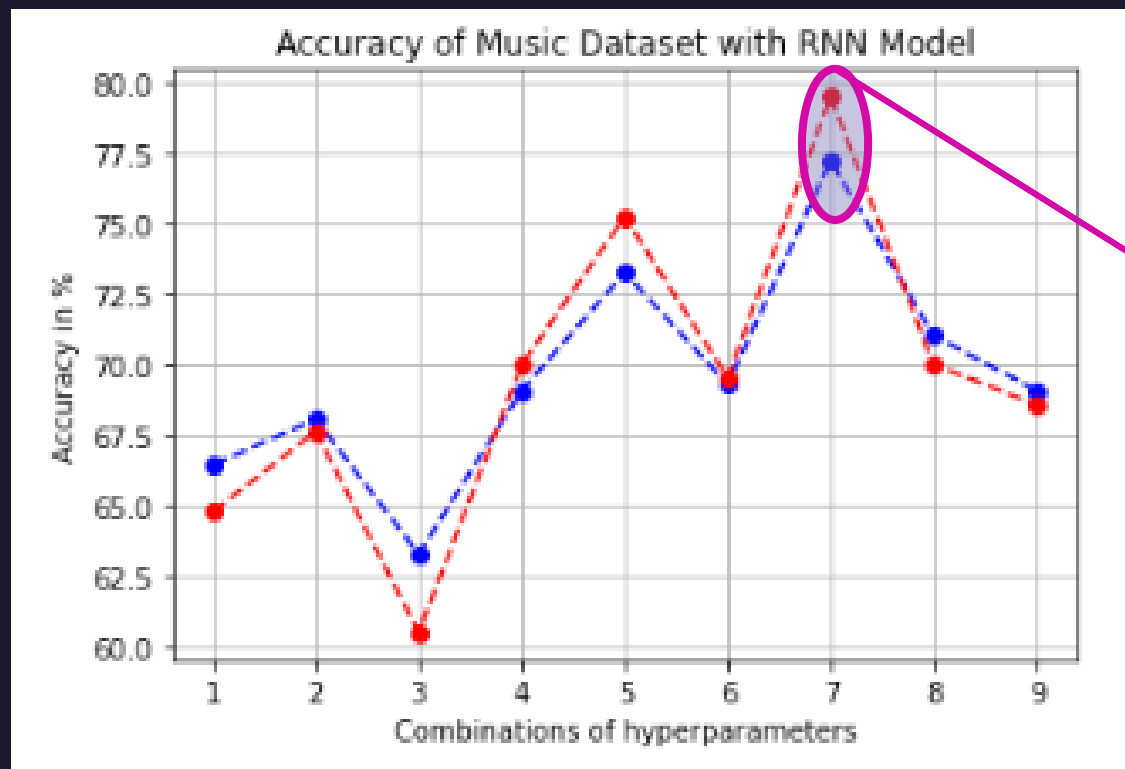
1. 5 - 8
2. 5 - 16
3. 5 - 32

4. 10 - 8
5. 10 - 16
6. 10 - 32

7. 20 - 8
8. 20 - 16
9. 20 - 32

BASELINE: RNN MODEL

MUSIC DATASET



```
hidden_size = 64
num_epochs = 20
batch_size = 8
Checking accuracy on training data
Got 757 / 980 with accuracy          77.244898
Checking accuracy on val data
Got 167 / 210 with accuracy          79.523810
Checking accuracy on test data
Got 170 / 210 with accuracy          80.952381
```

Combinations of hyperparameters [“number of epochs” - “batch size”]

1. 5 - 8
2. 5 - 16
3. 5 - 32

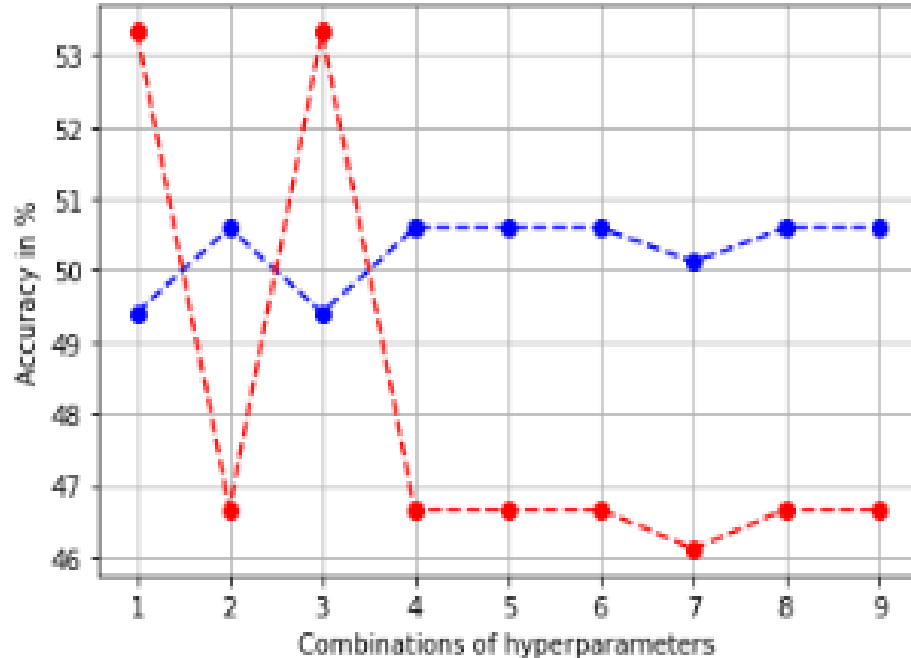
4. 10 - 8
5. 10 - 16
6. 10 - 32

7. 20 - 8
8. 20 - 16
9. 20 - 32

BASELINE: RNN MODEL

MEDITATION DATASET

Accuracy of Meditation Dataset with RNN Model with no Transfer Learning



Combinations of hyperparameters [“number of epochs” - “batch size”]

- 1. 5 - 8
- 2. 5 - 16
- 3. 5 - 32

- 4. 10 - 8
- 5. 10 - 16
- 6. 10 - 32

- 7. 20 - 8
- 8. 20 - 16
- 9. 20 - 32

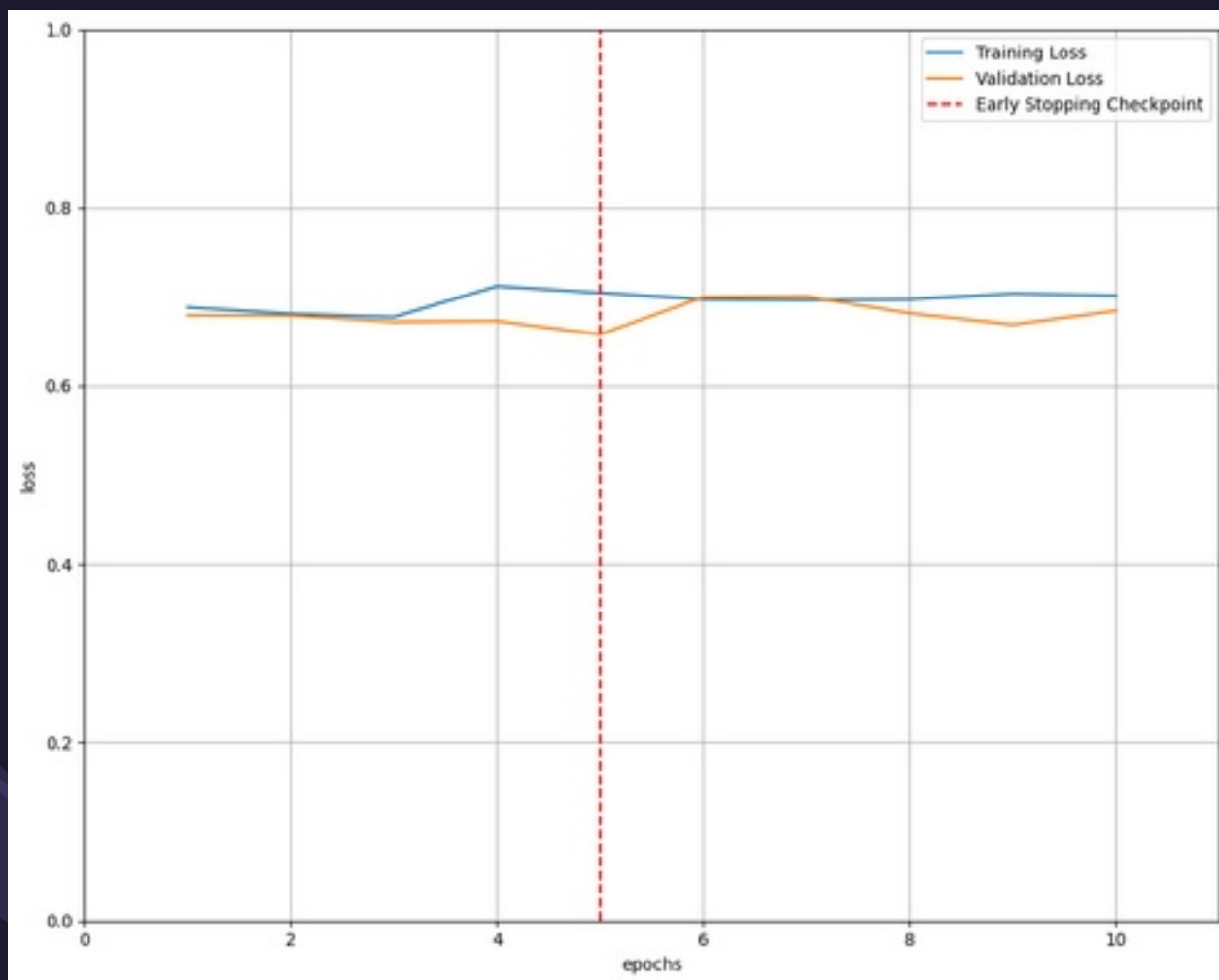
Dimensionality

Instability

Poor accuracy

BASELINE: RNN MODEL

MEDITATION DATASET



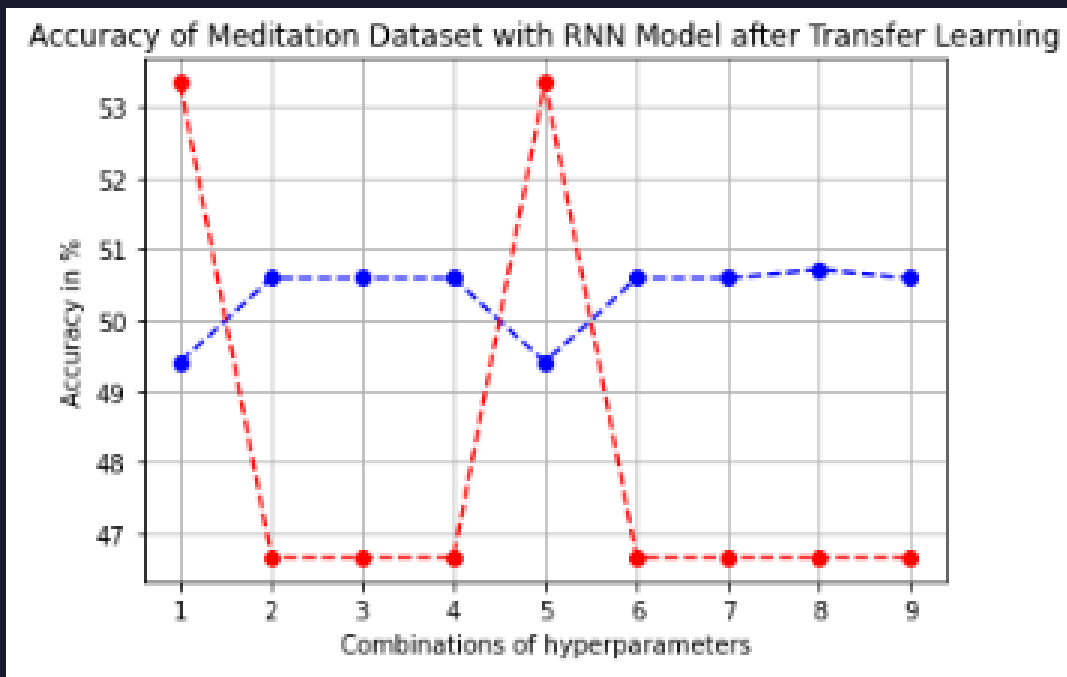
Dimensionality

Instability

**Poor
accuracy**

RNN WITH TRANSFER LEARNING

MEDITATION DATASET



```
Checking accuracy on training data
Got 425 / 840 with accuracy          50.595238
Checking accuracy on val data
Got 84 / 180 with accuracy          46.666667
Checking accuracy on test data
Got 91 / 180 with accuracy          50.555556
--* done *--
```

- Same results most of the time
- Based on the music RNN Model only
- Freezing only the first layer

Combinations of hyperparameters [“number of epochs” - “batch size”]

1. 5 - 8
2. 5 - 16
3. 5 - 32

4. 10 - 8
5. 10 - 16
6. 10 - 32

7. 20 - 8
8. 20 - 16
9. 20 - 32

Applying Transfer Learning To Deep Learned Models For EEG Analysis

Axel Uran^{a,b}, Coert van Gemenen^b, Rosanne van Diepen^b, Ricardo Chavarriaga^a,
José del R. Millán^a

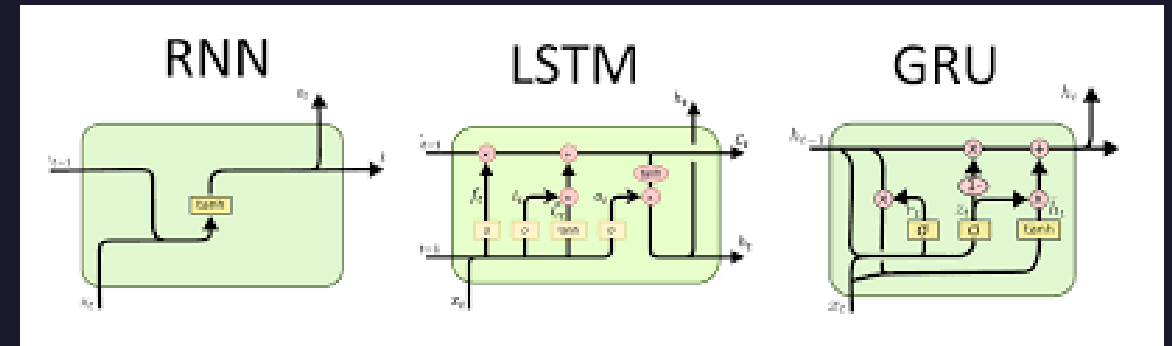
^a*Defitech Chair in Brain-Machine Interface, Ecole Polytechnique Fédérale de Lausanne (EPFL)*

^b*Alpha.One, Weena 250, 3032 AC, Rotterdam, The Netherlands*

logical data to enable training a model with limited amounts of data. Our method was tested on the dataset of the BCI competition IV 2a and compared to the top results that were obtained using traditional machine learning techniques. Using our DL model we outperform the top result of the competition by 33%. We also explore transferability of knowledge between trained models over different experiments, called *inter-experimental transfer learning*. This reduces the amount of required data even further and is especially useful when few subjects are available. This method is able to outperform the standard deep learning methods used in the BCI competition IV 2b *approaches by 18%*. In this project we propose a

<https://arxiv.org/pdf/1907.01332.pdf>

VI. EXTENDABILITY

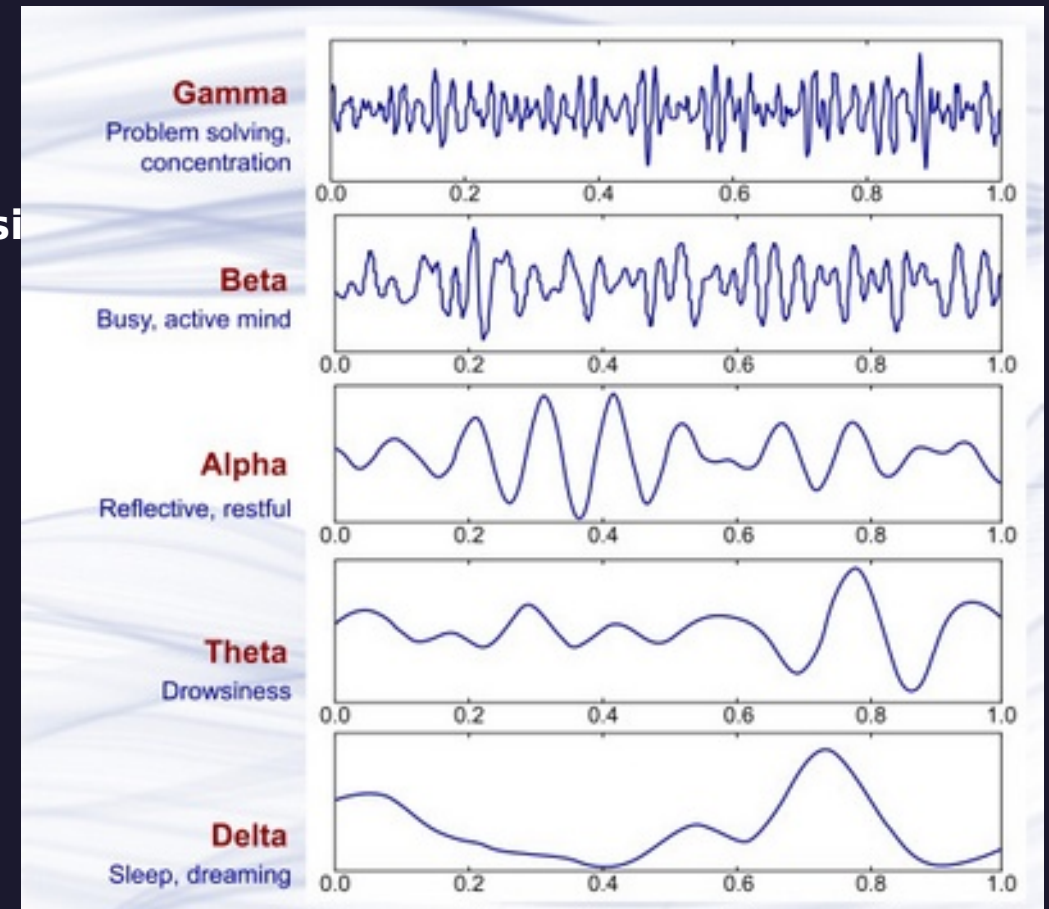


1. Preprocessing

- Feature Extraction instead of raw data
- Fourier Transformation(Frequency domain Analysis)
- Dimension Reductionality

2. Model

3. New analysis views



Merci!

