

Task

Overview

This task is centered around the analysis of EEG data to classify different cognitive states using advanced deep learning techniques. The data is sourced from the Mental Arithmetic Tasks Dataset available at PhysioNet (<https://physionet.org/content/eegmat/1.0.0/>). The dataset is pre-cleaned and ready for use, allowing you to focus on model implementation and evaluation. Please familiarize yourself with the dataset by reviewing the accompanying research paper (<https://www.mdpi.com/2306-5729/4/1/14>).

Objectives

You are required to implement and evaluate multiple deep learning models (suggesting to implement at least 2 models) using the Python library MNE. Your analysis should be documented in a Jupyter Notebook, which will be submitted via a GitHub repository link.

Steps to Achieve It

1. Load the EEG data
2. Power Spectral Density (PSD) Analysis:
 - a. Calculate the band-wise PSD for both states: rest (recording eeg dataset before mental arithmetic task) and task (recording of EEG dataset during the mental arithmetic task). Focus on the following frequency bands: Delta (1-4 Hz), Theta (4-8 Hz), Alpha (8-12 Hz), Beta (12-30 Hz), and Gamma (30-100 Hz).
 - b. Compare the PSDs of the two states and summarize your findings.
3. Deep learning classification:
 - a. Extract relevant features from the cleaned data
 - b. Implement binary classification using any two different deep learning models. You may choose from following models:
 - i. EEGNet
 - ii. TSception
 - iii. ViT (Vision Transformer)
 - iv. ATCNet
 - v. VAE (Variational Autoencoder)
 - c. Train and validate the model using the provided dataset.
 - d. Evaluate the models using appropriate metrics (accuracy, precision, recall, F1-score) and discuss the results.