

EEG Relaxation Analyzer

(Analysis and visualization of alpha brain waves associated with relaxation)

Introduction

Electroencephalography (EEG) is a technique used to record the brain's electrical activity. It allows the observation of different types of brain waves depending on a person's mental state (sleep, attention, stress, relaxation...).

This project aims to process and visualize EEG signals from public datasets in order to isolate alpha waves (8–12 Hz) and better understand their behavior.

The file S001R01.edf comes from the public EEG database PhysioNet, which contains recordings collected from human volunteers performing various tasks or resting states.

I – Frequency Analysis

We first analyzed the frequency distribution present in the EEG signal to identify the dominant bands.

Code used:

```
import mne
import matplotlib.pyplot as plt
import os

# 1. Load the EEG file (.edf)
raw = mne.io.read_raw_edf("/Users/asmaabou/Downloads/S001R01.edf", preload=True)

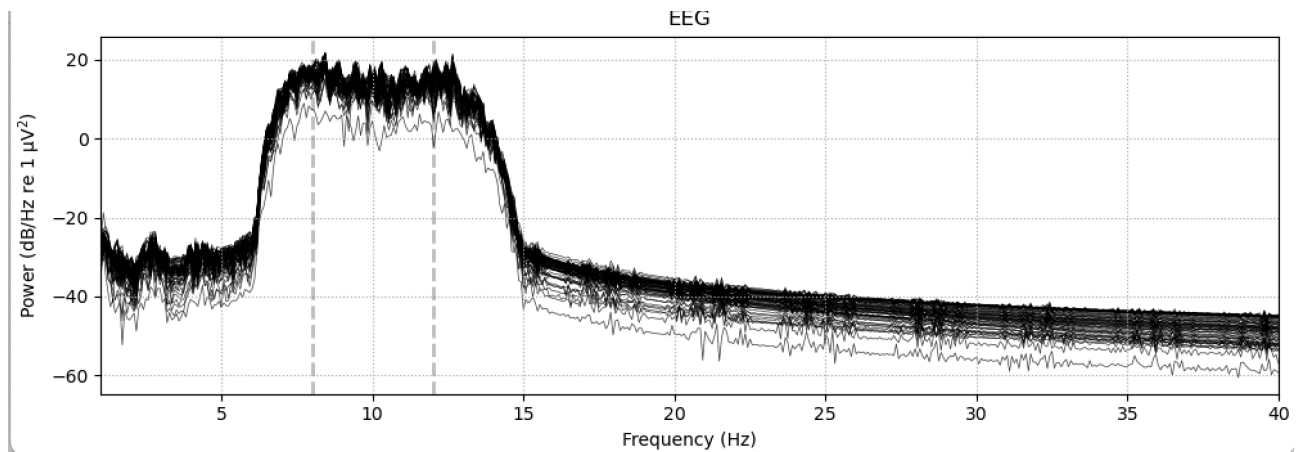
# 2. Filter the signal to keep only the alpha band (8–12 Hz)
raw.filter(8., 12.)

# 3. Compute the power spectrum between 1 and 40 Hz
psd = raw.compute_psd(fmin=1, fmax=40)

# 4. Plot the EEG spectrum
fig = psd.plot()

# 5. Create the "results" folder
os.makedirs("resultat_EEG", exist_ok=True)

# 6. Save the figure in the results folder
fig.savefig("resultat_EEG/spectre_alpha.png")
```



Interpretation

The power spectrum reveals a distinct peak between 8 and 12 Hz, corresponding to the alpha frequency band. This range is known to dominate during states of relaxed wakefulness, particularly when the eyes are closed and visual input is minimal.

Such activity reflects the brain's transition into an idling state, where cortical areas, especially in the occipital and parietal regions, reduce their processing load. The prominence of alpha rhythms in this recording therefore indicates a calm, resting mental state, consistent with physiological relaxation rather than active cognition.

II – Temporal EEG Analysis

We then visualized the EEG signal in the time domain, focusing only on the alpha frequency band.

```
import matplotlib.pyplot as plt

data, times = raw[:5, :2000] # 5 electrodes, 2000 samples (~12 s)

plt.plot(times, data.T)

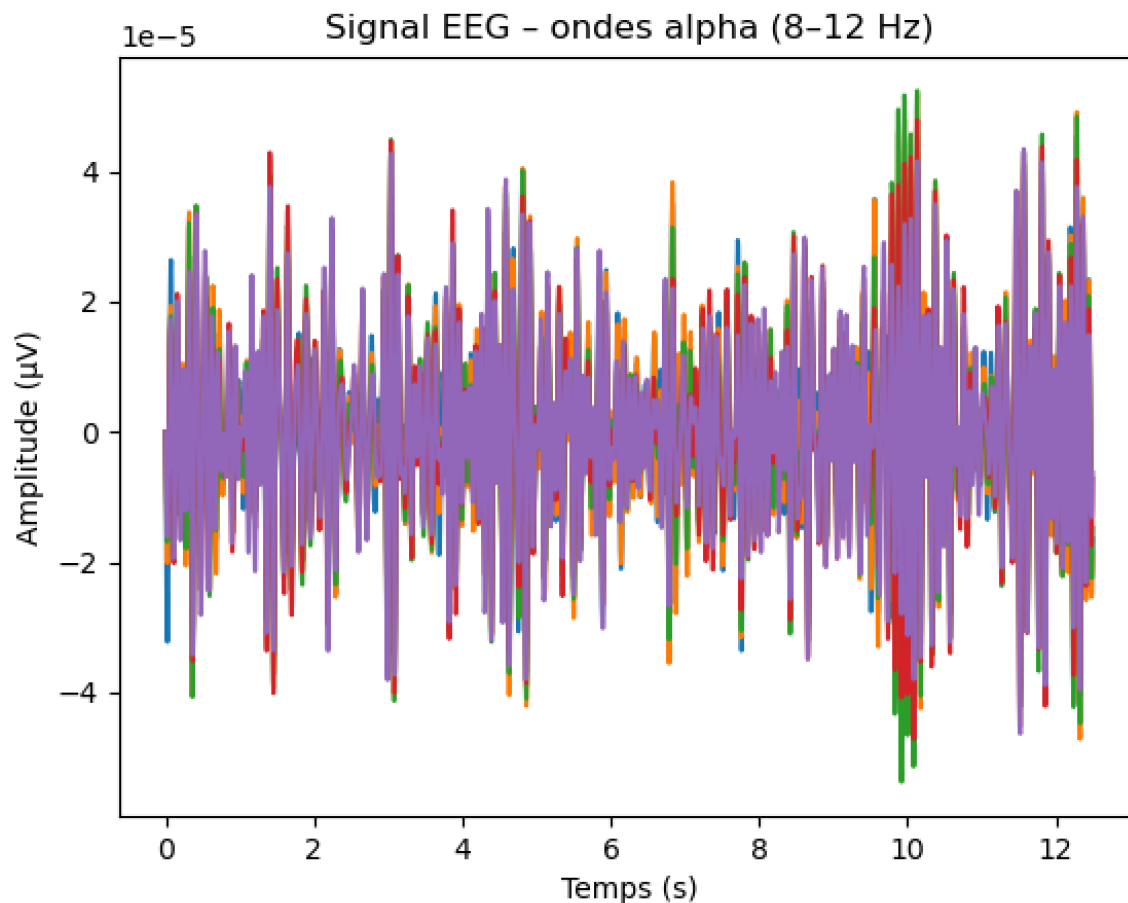
plt.xlabel("Time (s)")

plt.ylabel("Amplitude ( $\mu V$ )")

plt.title("EEG Signal – Alpha band (8–12 Hz)")

plt.savefig("results/signal_alpha.png")

plt.show()
```



Interpretation

The EEG signal filtered between 8 and 12 Hz shows regular oscillations recorded across several electrodes, corresponding to alpha activity.

These waves, synchronized across different brain regions, reflect a calm and relaxed resting state, typical of a subject with eyes closed.

Conclusion

This project highlights the presence of alpha activity in real EEG recordings.

Both frequency and time-domain analyses confirm the dominance of alpha waves, associated with mental relaxation and wakeful rest.

Through this mini-project, we demonstrate how Python and the MNE library can be used to extract, filter, and visualize meaningful information from EEG data.