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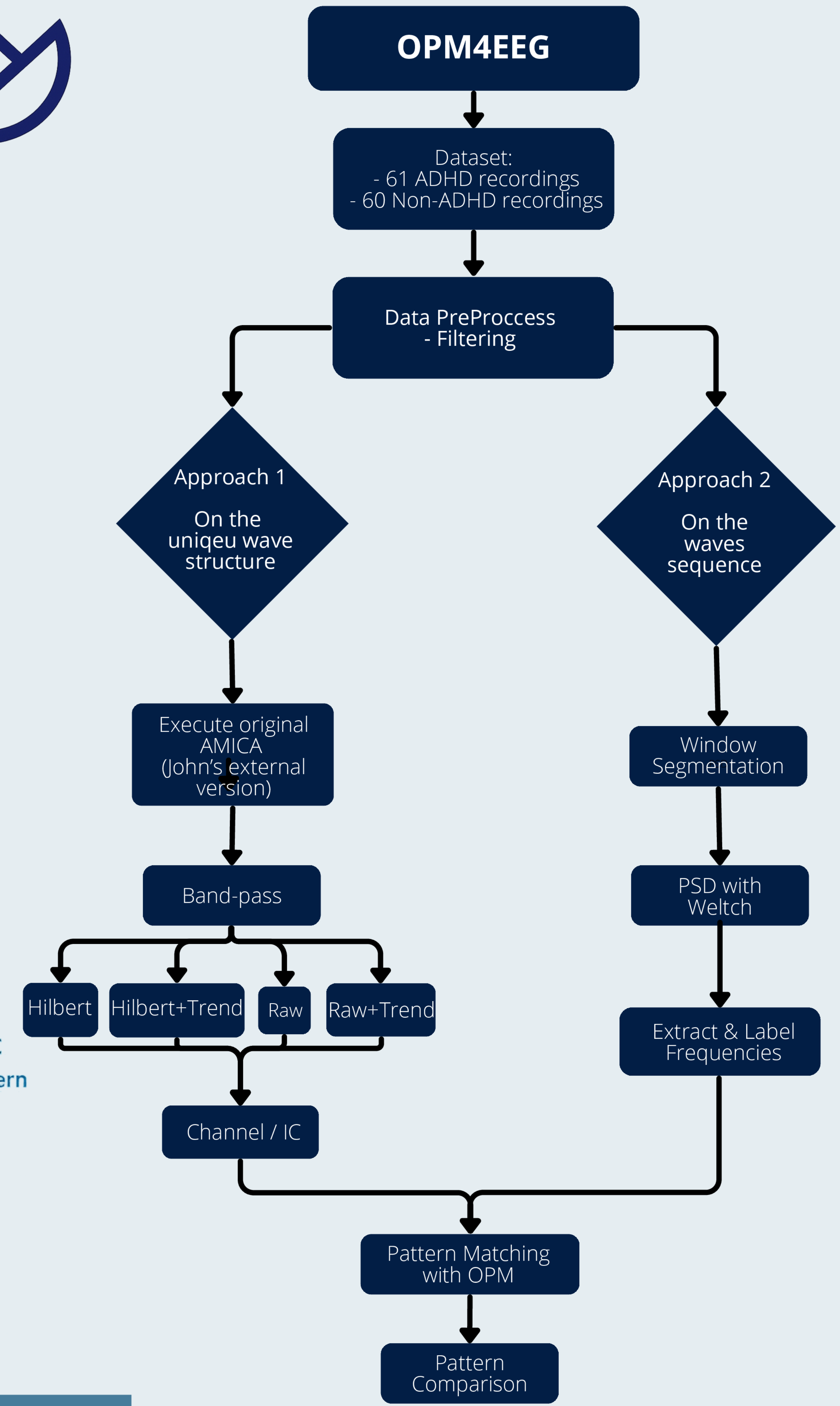
המכללה האקדמית להנדסה בראודה בכרמיאל

OPM4EEG

This project investigates how EEG signal patterns can help distinguish between children with ADHD and a control group.
Current ADHD diagnoses often rely on behavioral assessments, which are subjective and inconsistent.
By identifying EEG-based neural signatures through frequency analysis and the Order Preserving Matching (OPM) algorithm, we aim to develop a more objective, data-driven approach to ADHD diagnosis.
Our goal is to detect recurring EEG patterns that characterize ADHD and assess whether these can serve as consistent and reliable biomarkers.

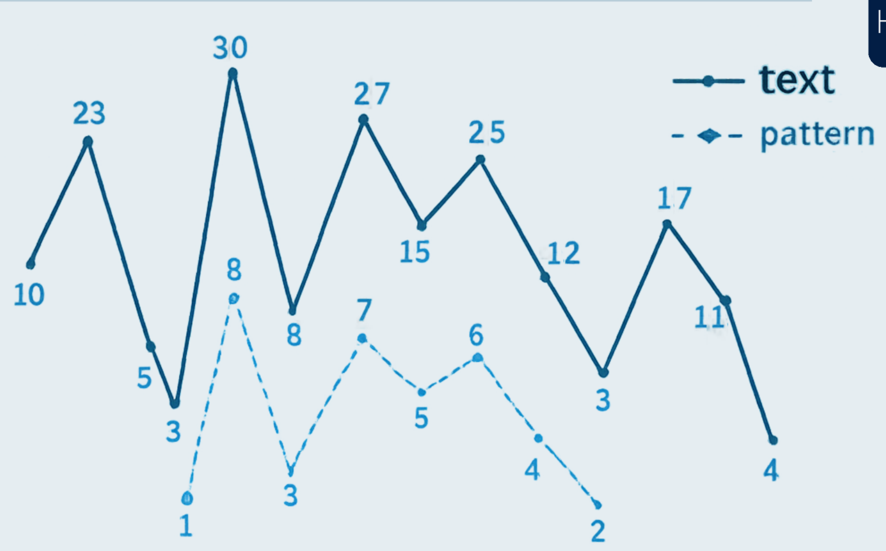


WHAT IS OPM?

Order Preserving Matching (OPM) is a symbolic pattern detection technique used to find recurring ordered sequences in time series data.
In this project, OPM is applied to EEG signals to identify symbolic patterns in brain activity that maintain the relative order of frequency bands over time.
Unlike traditional similarity measures, OPM focuses on the structure and order of signal components, making it ideal for analyzing subtle neural dynamics.

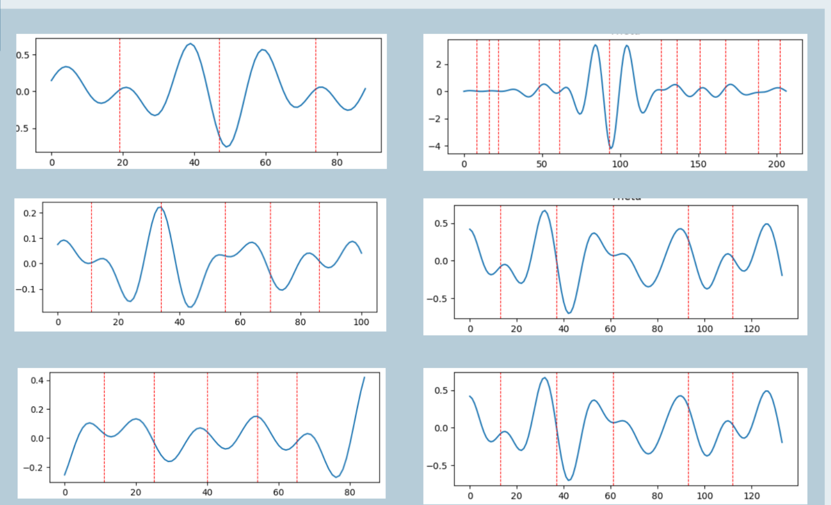
METHODOLOGY

We cleaned the raw EEG data using standard preprocessing.
Two analysis approaches were applied:
- Examining the shape of the EEG waveform using OPM.
- Detecting frequency sequences using the OPM algorithm.



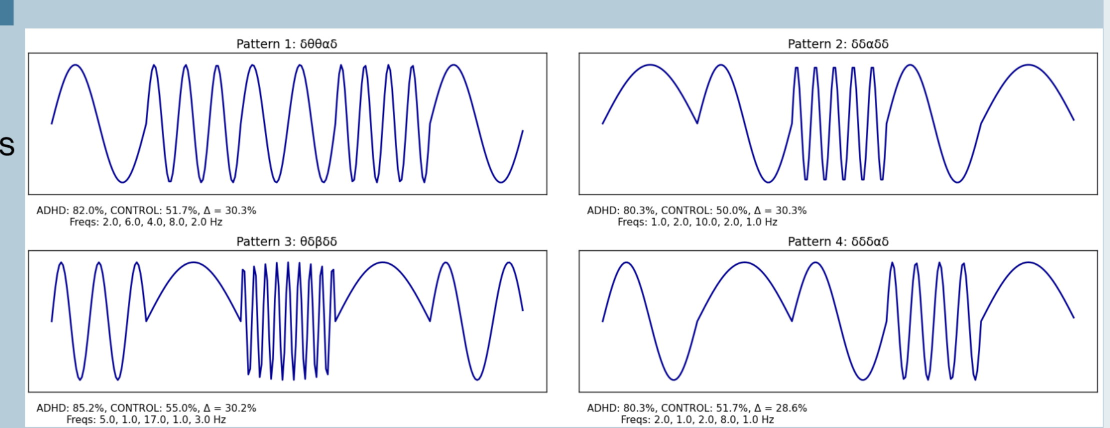
RESULTS (APPROACH 1)

In the images, the raw theta wave is split into individual cycles at each peak and trough (red lines). By measuring each cycle's duration, peak height, trough depth, and rise/fall slopes, we extract shape features that let us recognize and classify distinct waveform patterns.



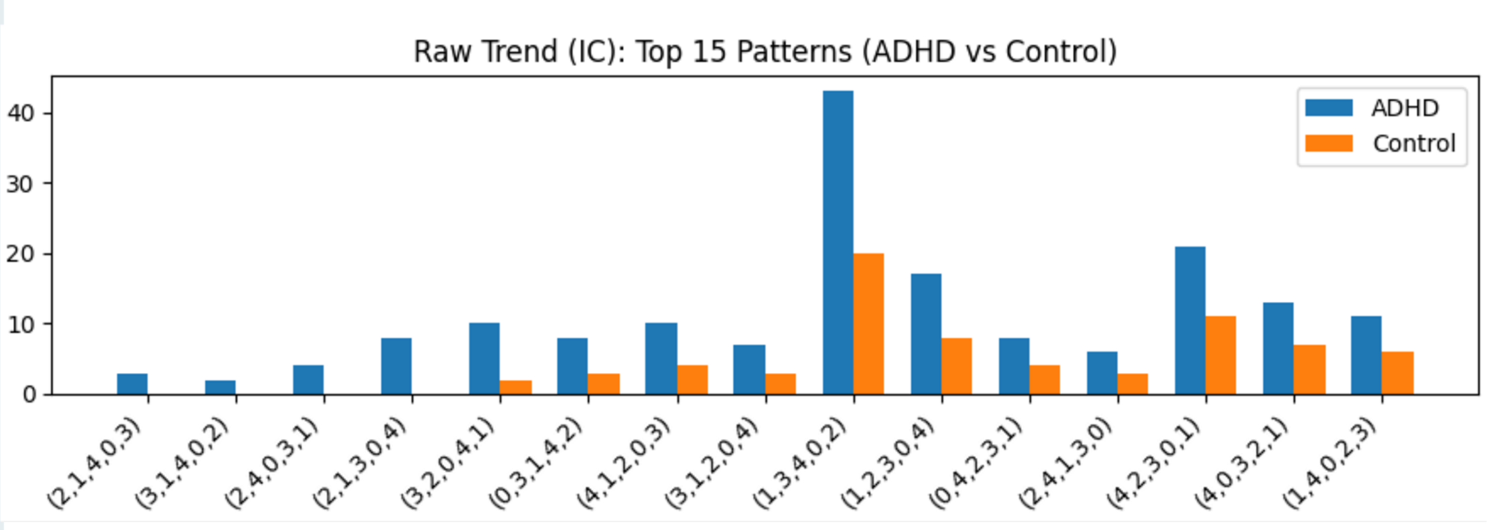
RESULTS (APPROACH 2)

The algorithm identified multiple frequency label patterns that appeared in ≥80% of ADHD subjects and lower presence in the Control group 50%–55%. These patterns consistently matched known neurological markers of ADHD, demonstrating the potential of EEG-based biomarkers for classification and diagnostic support.



ANALYSIS (APPROACH 1)

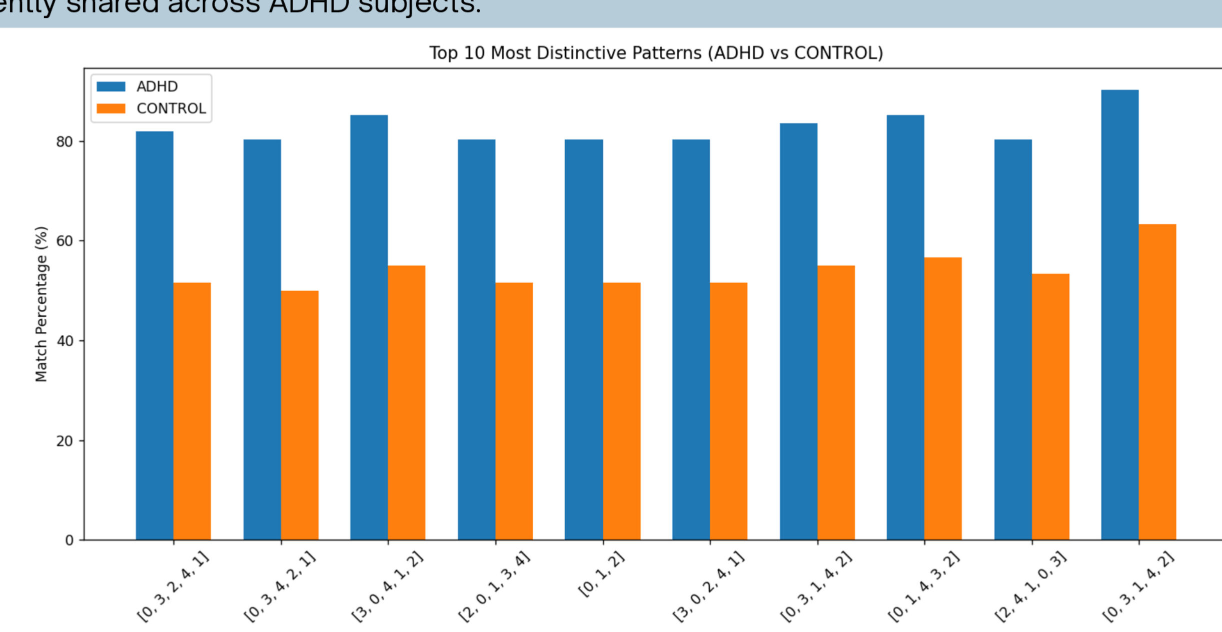
In this approach we search for repeating waveform structures directly on the original, noise-filtered independent component signals by detecting trend reversals and computing OPM motifs; the chart shows the top 15 patterns, and several motifs—such as (1,3-4,0,2) and (4,2-3,0,1)—occur two to three times more often in ADHD subjects than in controls, demonstrating that the raw waveform shapes alone carry distinctive neural signatures of ADHD.



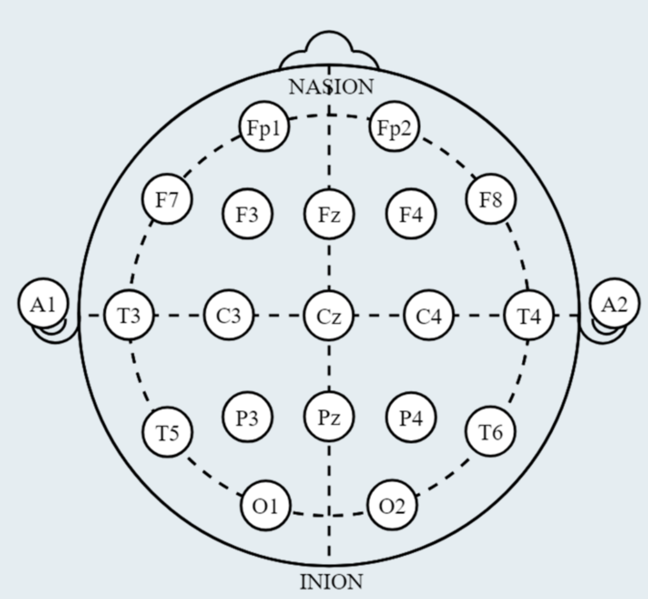
The 15 most prominent symbolic EEG patterns found in the ADHD group in the search for OPM patterns on a series of signal reversal points after band pass.

ANALYSIS (APPROACH 2)

Top 10 patterns exhibited strong presence in the ADHD group (typically over 80%) and substantially lower presence in the Control group (mostly around 50%–55%).
Although we also tested longer patterns during the OPM analysis, none of them ranked among the top 10 most distinctive. This may indicate that longer symbolic sequences are either less robust or less consistently shared across ADHD subjects.



Top 10 most distinctive symbolic EEG patterns found in the ADHD group (using 1s windows, 50% overlap), and their appearance rate in the Control group



CONCLUSIONS

Our analysis revealed recurring EEG patterns that differ between ADHD and control groups, with some motifs appearing up to 30% more frequently in ADHD subjects. Using OPM, we identified symbolic frequency sequences exhibiting distinct group-specific distributions and observed significant intergroup gaps even when strict match thresholds weren't always met. These results support the idea that raw waveform shapes carry meaningful neural signatures and may contribute to future ADHD diagnostics and brain-signal analysis.

The next idea for the study: is to combine the approaches into a single approach of finding OPM patterns on the wave and then looking for OPM patterns on a combination of different waves, which may create significantly better results among the ADHD group.