

Abstract

Objective: This research aims to develop a machine learning model using EEG data to identify student inattention, serving as an early intervention tool. The model also does details spectral ratio analysis in frontal lobes to identify shift in attention.

Background: Attention deficit, influenced by social media, adversely affects student performance. ADHD, characterized by inattention, hyperactivity, and impulsivity, is linked to academic challenges. Early detection in attention in academics is crucial to provide appropriate intervention.

Method: A Machine Learning model was designed, trained on an attention dataset with 34 EEG recordings of young adults. The raw EEG data was pre-processed and filtered, ICA was applied, and spectral analysis was done. Guided meditation with music was developed as an intervention to improve attention.

Experiment: EEG recordings from 15 young adults during a visual reasoning test and meditation assessed the model's efficacy by comparing model output to test scores.

Results: ML: ML model achieved a 98% accuracy rate to classify attention vs inattention states. During the evaluation, it was found that the model predicted with similar accuracy in detecting people in attention states.

CM-II: Key findings include Theta-to-Beta Ratio (TBR) indicating deepened introspection, Theta-to-Alpha Ratio (TAR) showing enhanced relaxation, Delta-to-Theta Ratio (DTR) reflecting deep introspection, and Theta-to-Gamma Ratio (TGR) suggesting increased internal reflection and reduced thinking. ML model verified that post-meditation, all participants showed increased attention, supported by online tests, marking a significant improvement from initial inattention.

Introduction

- The rising prevalence of attention deficits in students, often linked to social media, adversely impacts their academic achievements. Inattention, characterized by a lack of focus or oversight of details, has been frequently correlated with academic underperformance in numerous studies.
- Students diagnosed with Attention Deficit Hyperactivity Disorder (ADHD) - a neurodevelopmental condition marked by inattention, impulsivity, and hyperactivity - face higher risks of underachieving. Many of these students might even drop-out without securing a final degree.
- An early detection can help manage attention levels and mitigate these effects.



Why early detection? - Statistics

- ADHD results in societal and joblessness costs for children and adolescents, approximated at \$19.4 billion and \$13.8 billion respectively in the US [1].
- In 2022, a 40% college dropout rate led to a \$31 billion financial hit nationally [1].
- Traits of ADHD were observed to hinder academic success (e.g., GPA) in engineering courses [2].
- Symptoms of inattention can lead to challenges in organizing, maintaining effort, and managing time [2].

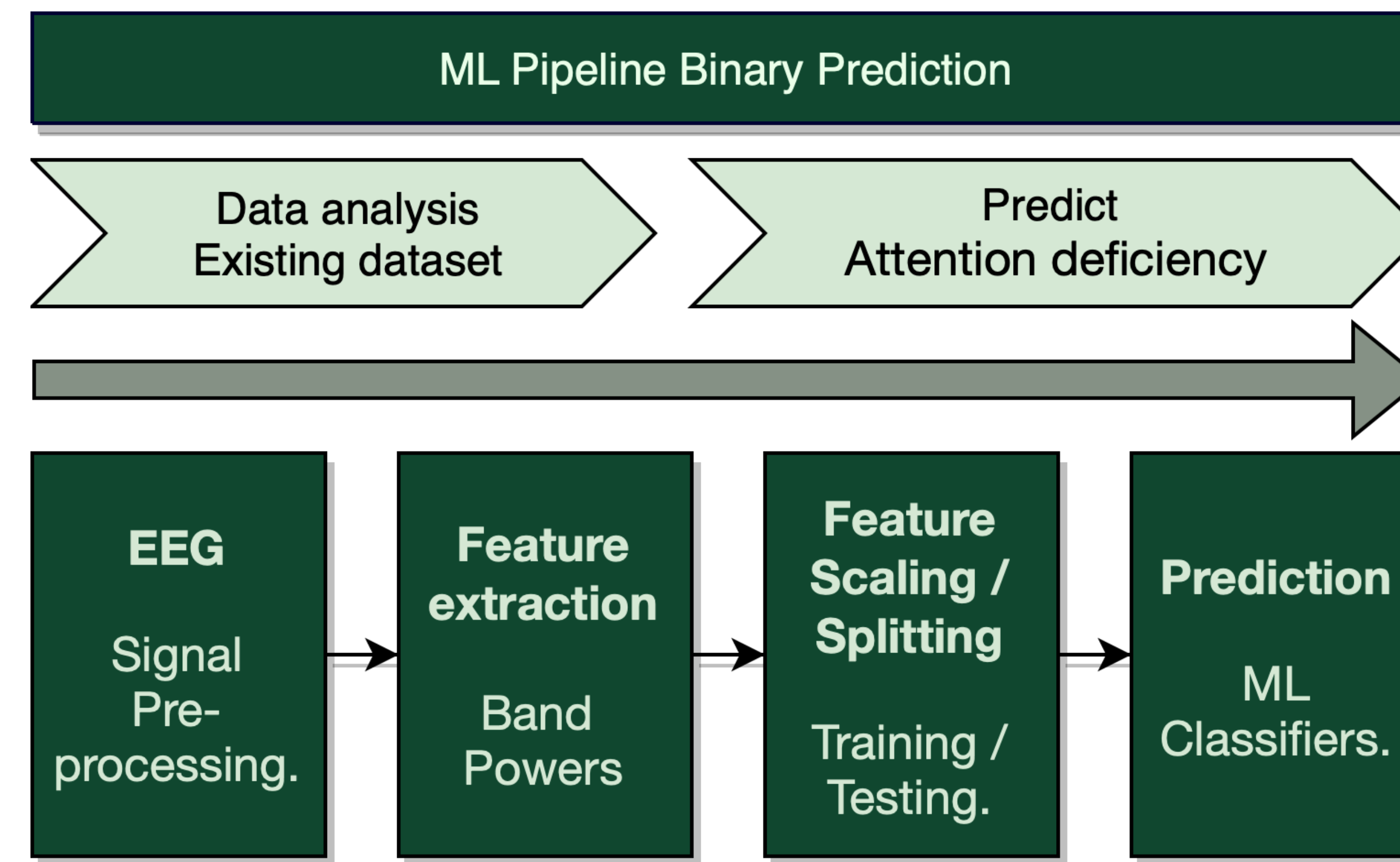


Meditation as an intervention: CM-II Stages

Guided meditation with background music was developed for daily practice.

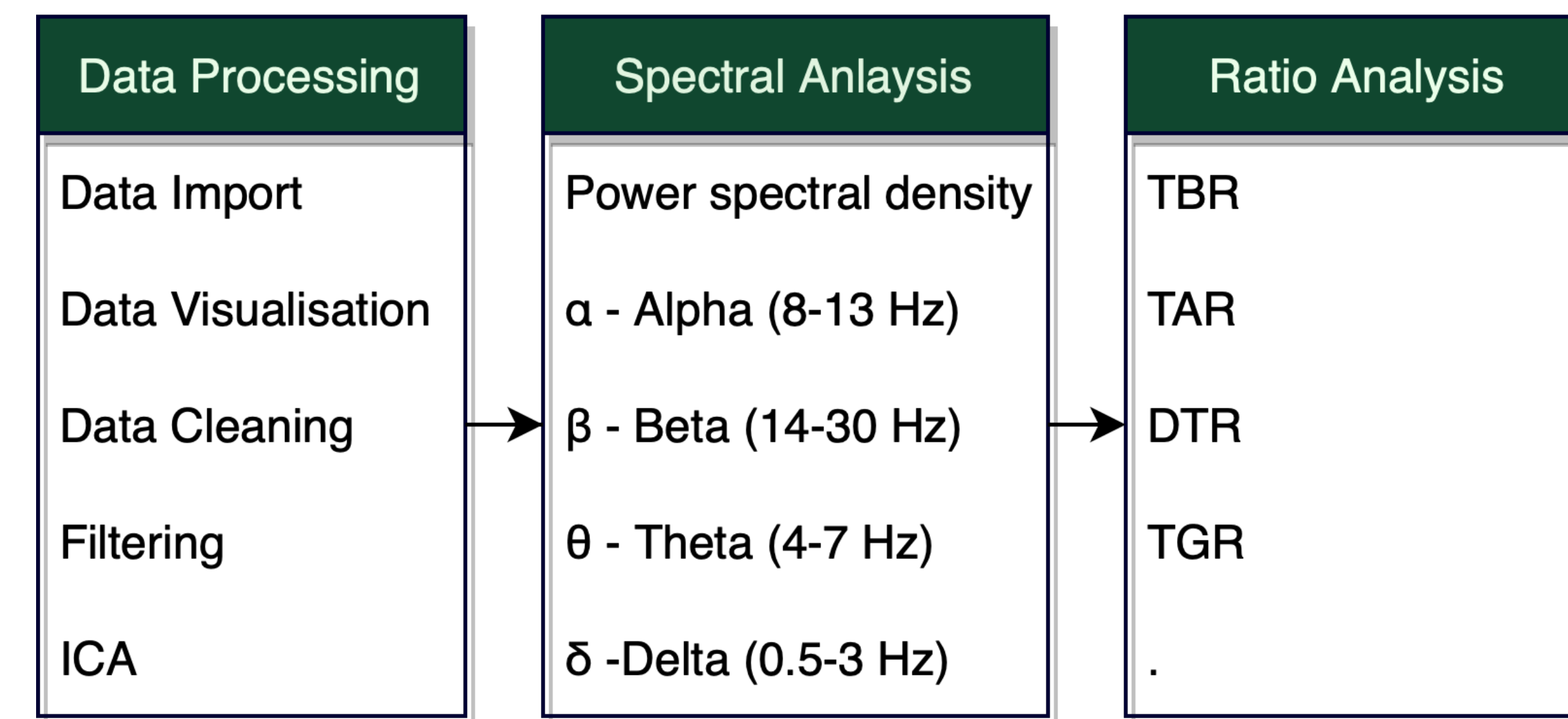
- Emotional review**
 - Exploring memories of fear, hurt, etc. related to inattention.
- Analyzing challenges**
 - Reviewing past events of the day related to various aspects of life.
 - Finding possible solutions and actions within.
- Rehearsing solutions for a day**
 - Visualizing the solutions with positivity and indulging in related tasks with creativity, seeing solutions, and positive outcomes internally; Feeling gratitude.

Methodology



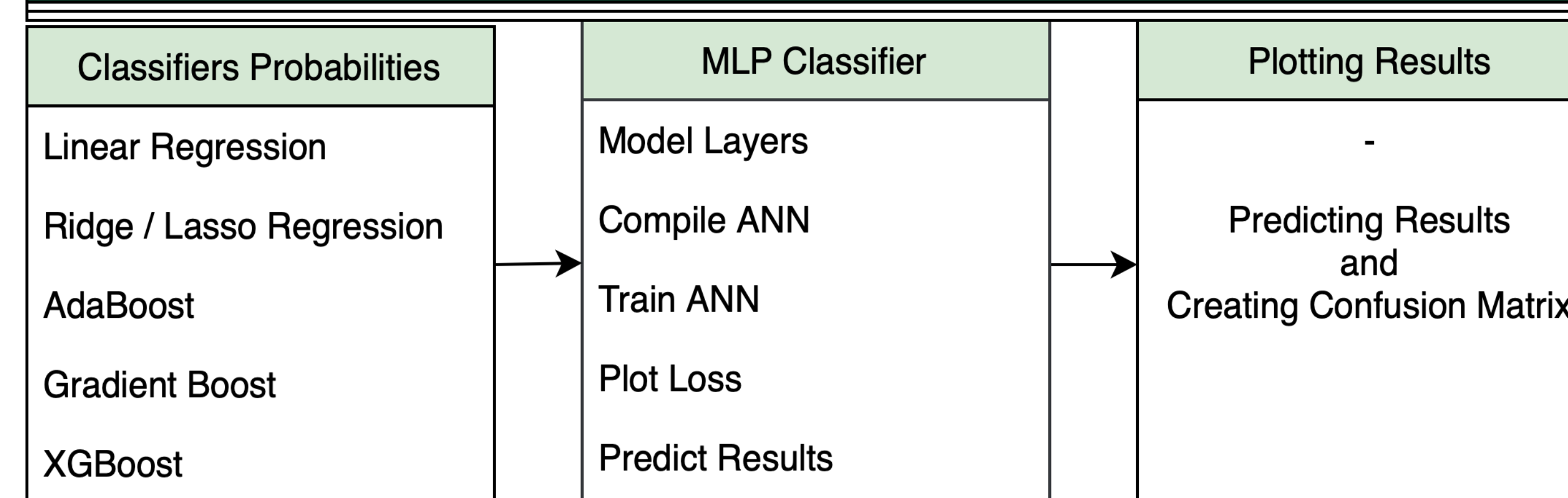
Raw EEG dataset filtered, feature engineered, extracted band waves and trained ML model to predict attention states. 89% accuracy (NN) and 98% accuracy (Ensemble) [4]. The model was trained using EEG attention dataset [6] that was labelled as attention vs inattention among 34 recordings of 5 participants [6].

Spectral Ratio Analysis Flow



Raw EEG dataset filtered, feature engineered, extracted band waves and analyzed spectral ratios to study attention level fluctuations [5].

ML Model Architecture



Innovative ML Model: Ensemble Models + Neural Networks Increase in accuracy from 88% to 98% observed for MLP model [4].

Experiment

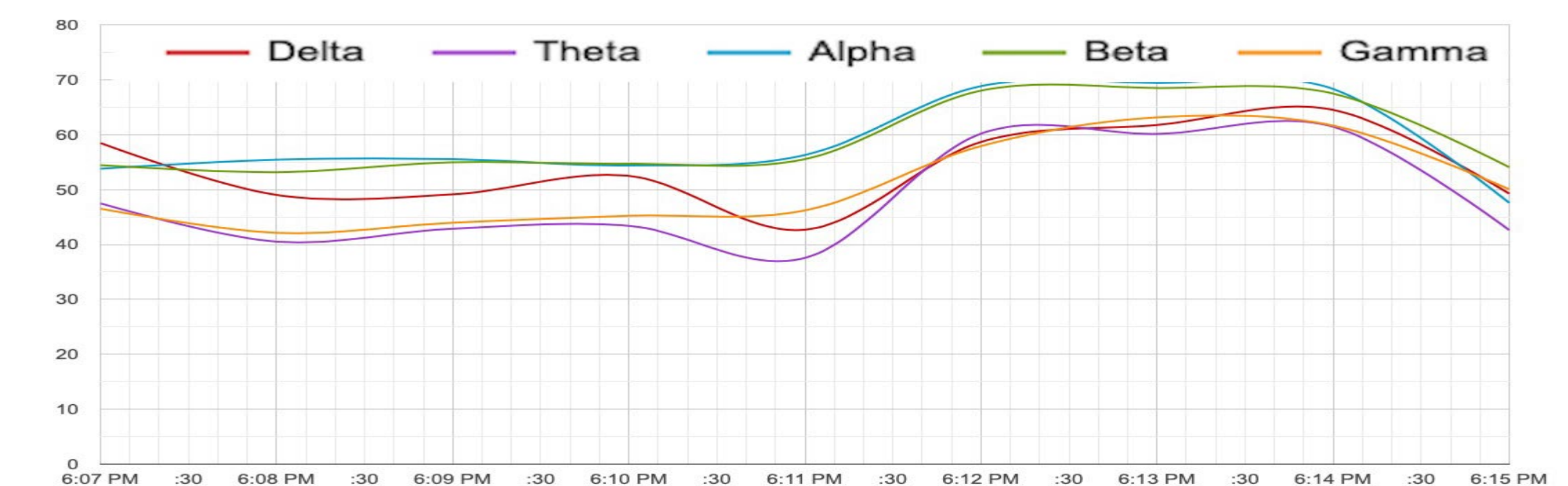
An in-person experiment was conducted for 15 college students mostly from computer science. To evaluate the effect of CM-II meditation we EEG during the pre-test, meditation, and post-test. 4 Channel Muse 2 EEG device was used which provides insights from frontal and temporal lobes. The EEG from frontal lobes was analyzed, attention states predicted, and spectral ratio analysis was conducted.



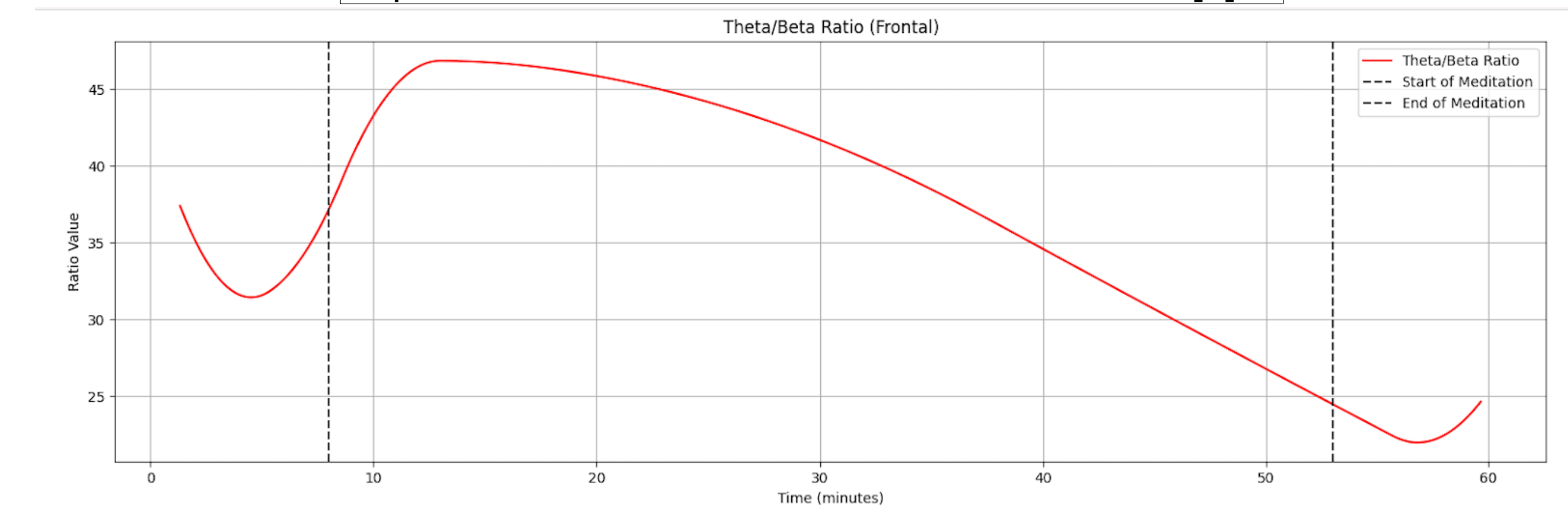
Results

Detailed ratio shifts provided insights into meditation's cognitive impacts. The spectral ratio analysis inferred as follows:

- TBR - deepened introspection and maintained attention.
- TAR - enhanced relaxation and meditation depth.
- DTR - Deep introspection.
- TGR - amplified internal reflection and minimized external processing.



Alpha and Beta Waves rise after meditation [4]



Overall, Theta-Beta Ratio decreasing over time – indicates rise in Attention [5]

In addition to the spectral analysis, the post-attention test results showed that 93% of the participants moved into attention after CM-II meditation.

Conclusion

The results of this study could be useful for the audience in various ways. Firstly, the AI solution we developed could be used in measuring attention by using EEG data from a portable device. Secondly, CM-II meditation could be used to improve student attention and performance. This could be useful for educators and researchers who are interested in developing interventions for addressing attention issues in students.

References

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