EEG SIGNAL CLASSIFICATION

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UNDERSTANDING EEG SIGNALS

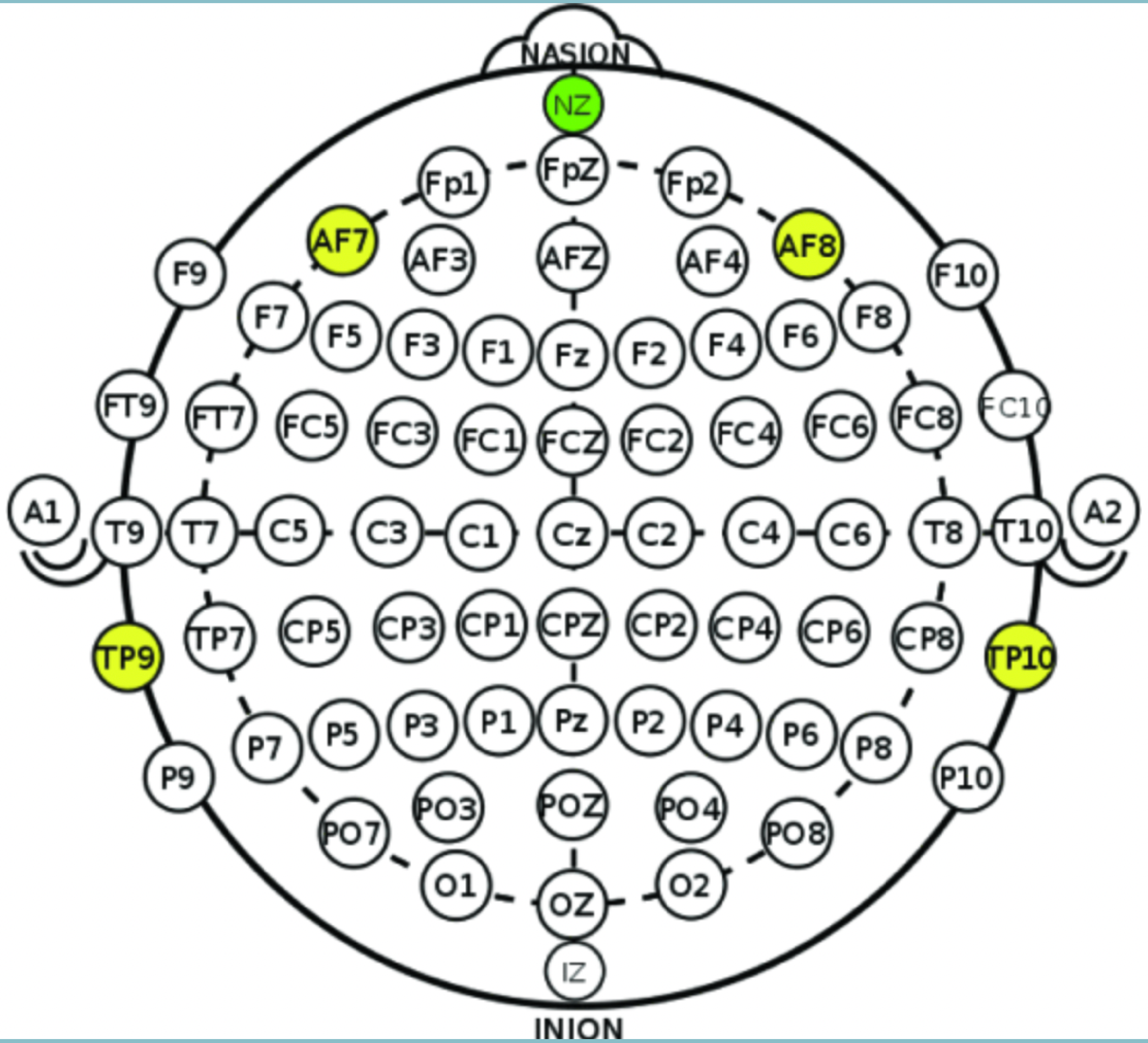
- Electroencephalography (EEG) records electrical activity in the brain using scalp electrodes.
- Captures real-time patterns of neuronal impulses, offering insights into brain function.
- Raw EEG data reflects cognitive processes, emotional states, and neurological conditions.
- Provides a non-invasive means to link brain activity to behavioral and biological reactions.

EEG & MACHINE LEARNING

- Machine learning models analyze EEG data, revealing patterns and abnormalities.
- These models enhance medical responses to neurological disorders through improved diagnostics and treatment planning.
- Machine learning models decode brain signals for controlling devices, and prosthetics, and aiding individuals with motor impairments.

EEG DATASET

- The dataset I used contained data pertaining to an experiment, studying various mental states, concentrated, relaxed, and neutral, under EEG recordings.
- The dataset contained:
  - 4 participants
  - 5 electrodes
  - 24 total EEG recording sessions


NASION
NZ
Fp1
FpZ
Fp2
AF7
AF3
AFZ
AF4
AF8
F9
F7
F5
F3
F1
Fz
F2
F4
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F10
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A1
T9
T7
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C2
C4
C6
T8
T10
A2
TP9
TP7
CP5
CP3
CP1
CPZ
CP2
CP4
CP6
CP8
TP10
P9
P7
P5
P3
P1
Pz
P2
P4
P6
P8
P10
PO7
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POZ
PO4
PO8
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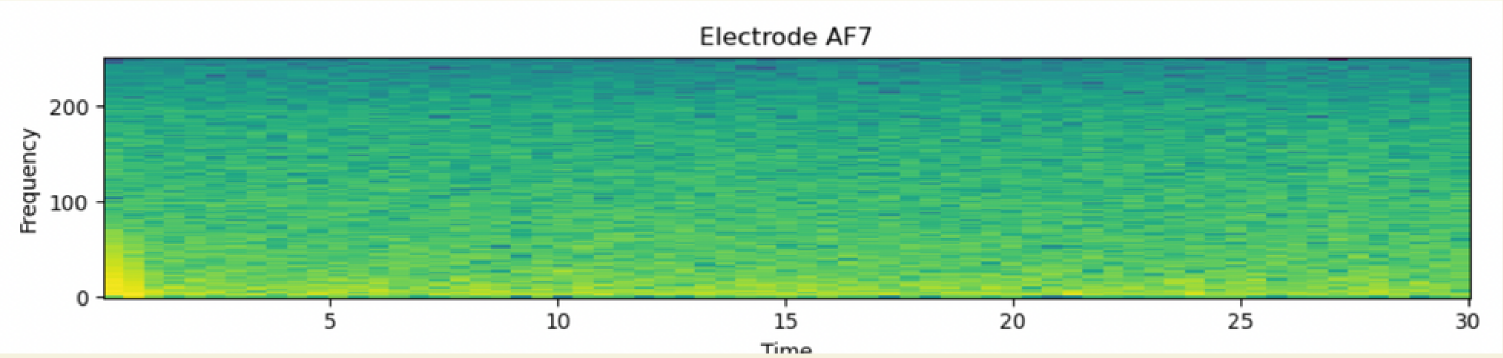
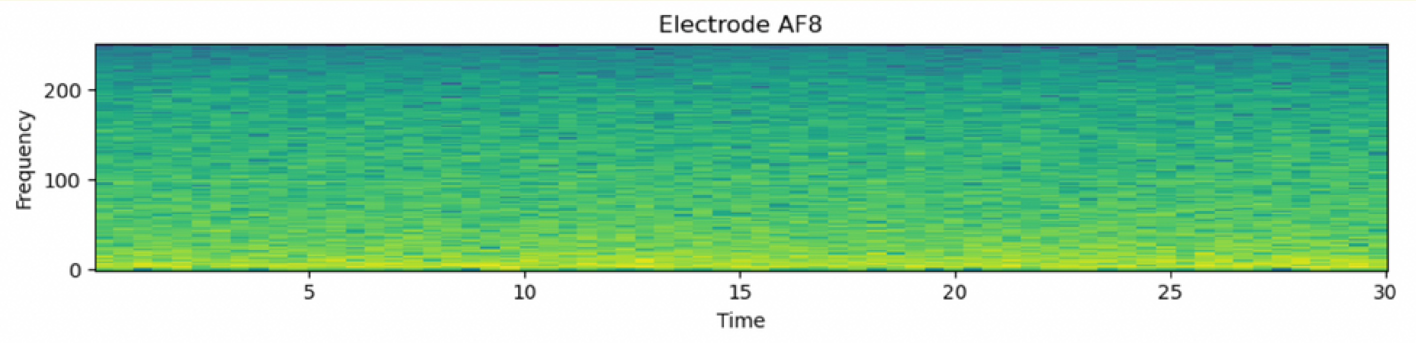
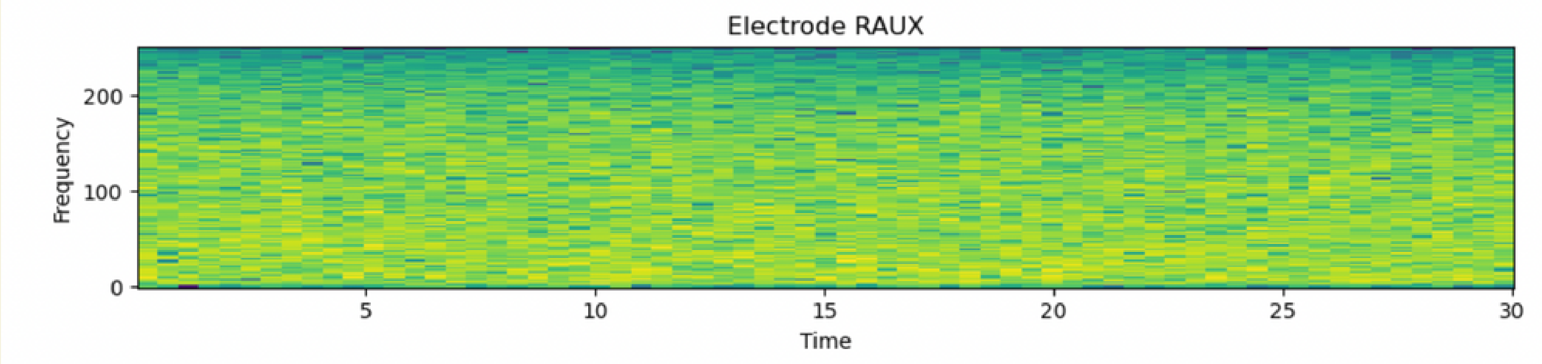
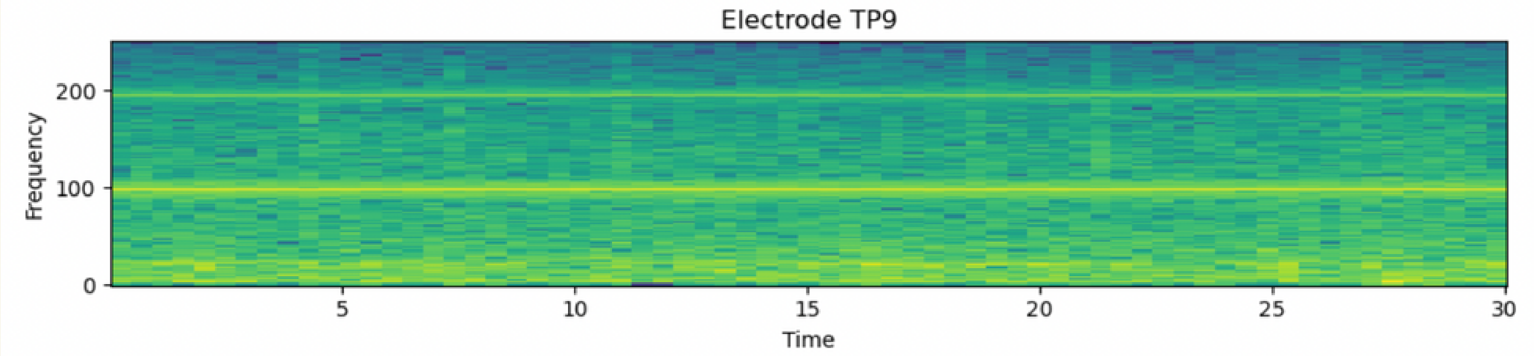
OZ
O2
IZ
INION

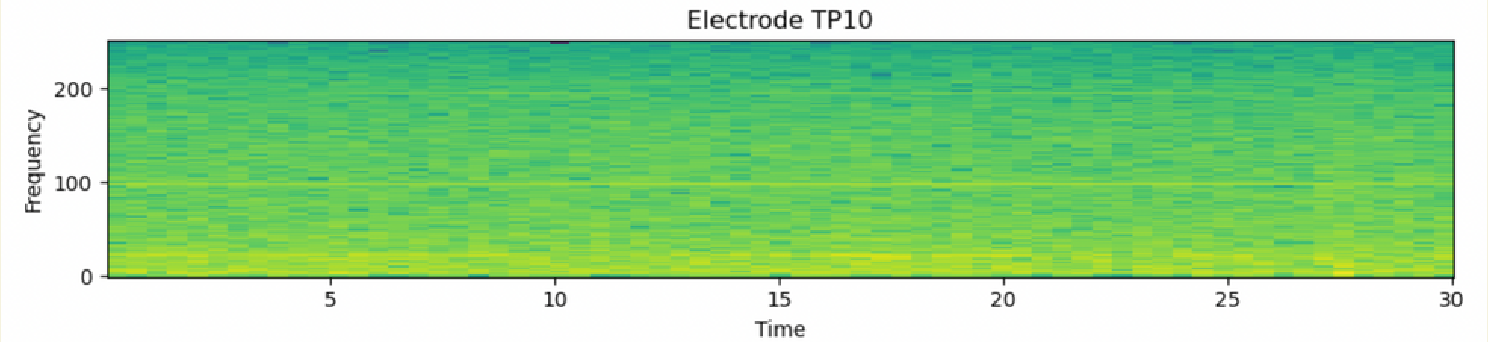
SPECTROGRAM READINGS





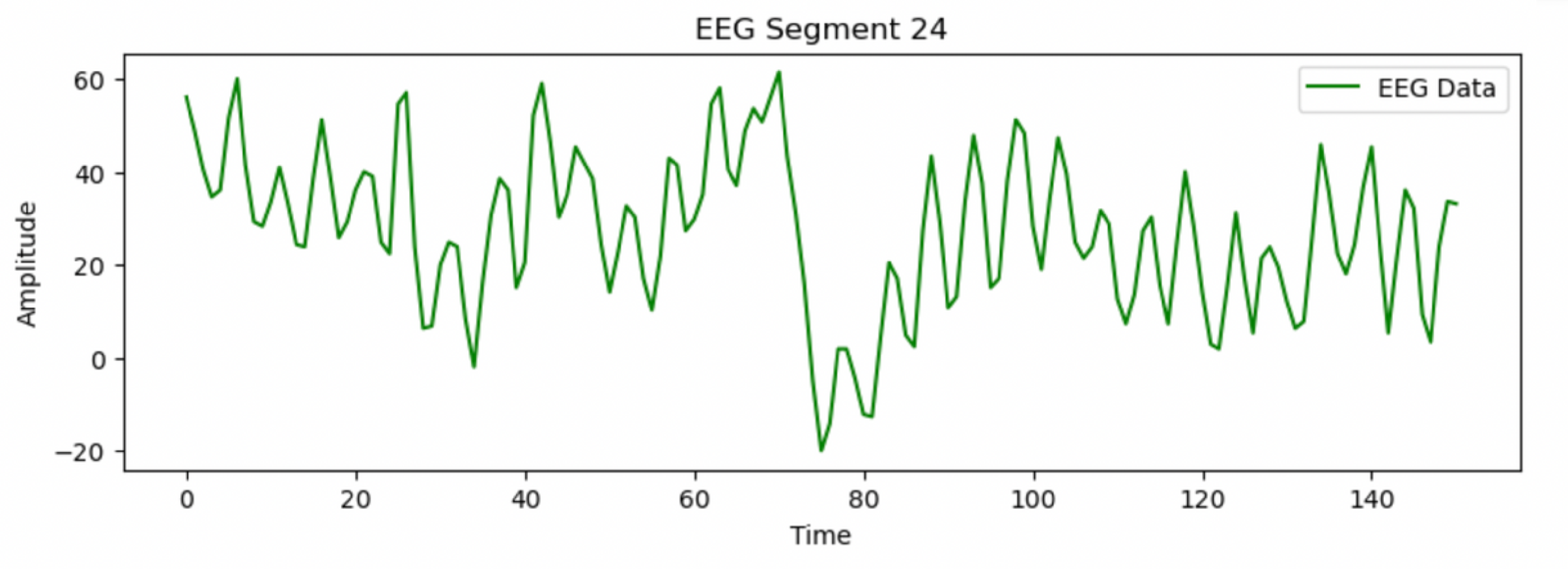


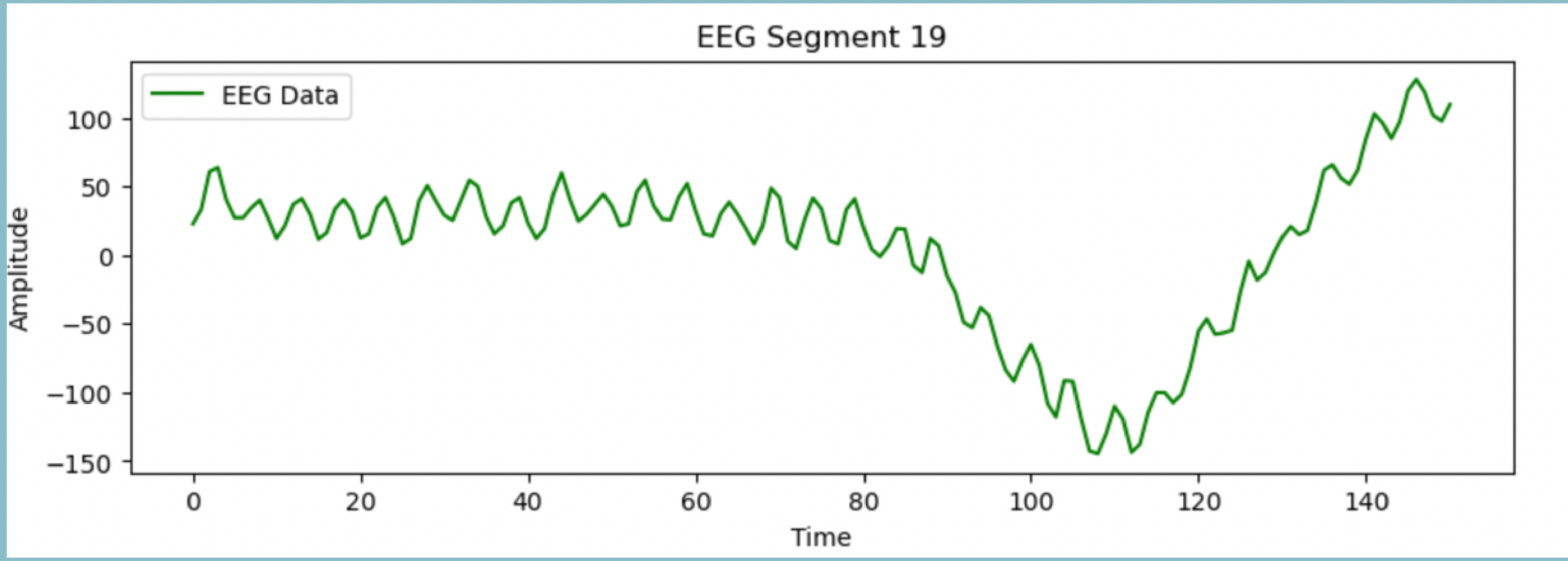


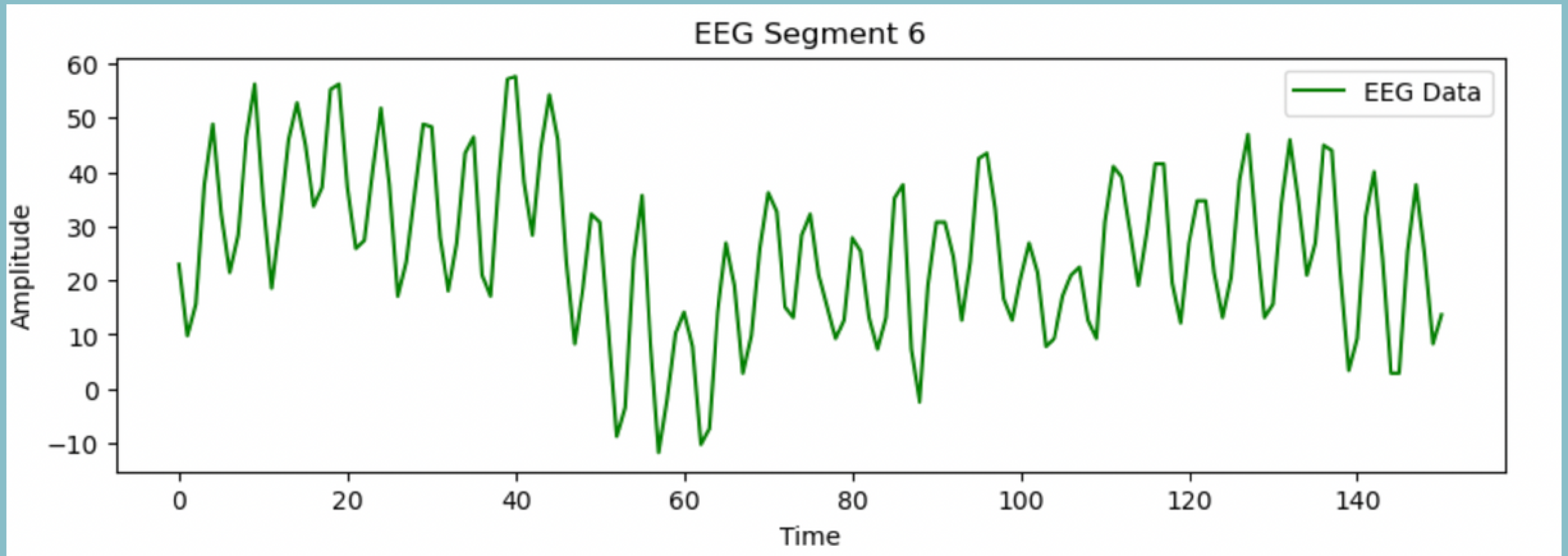


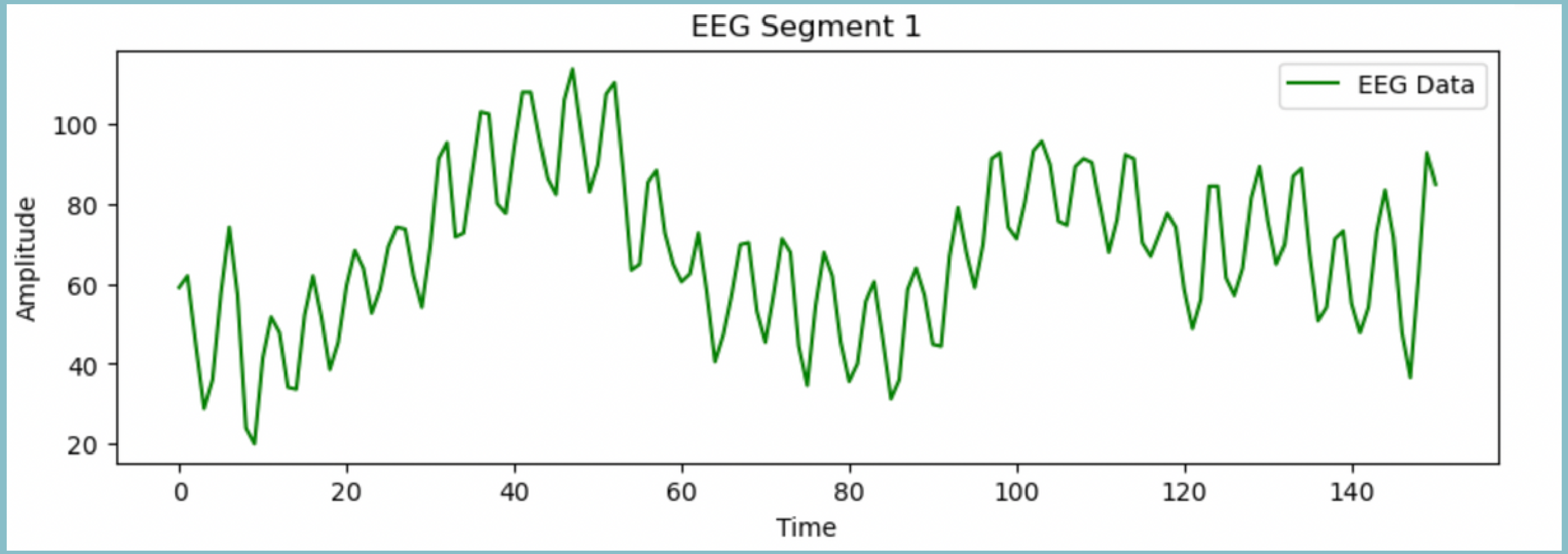
DATA PREPROCESSING

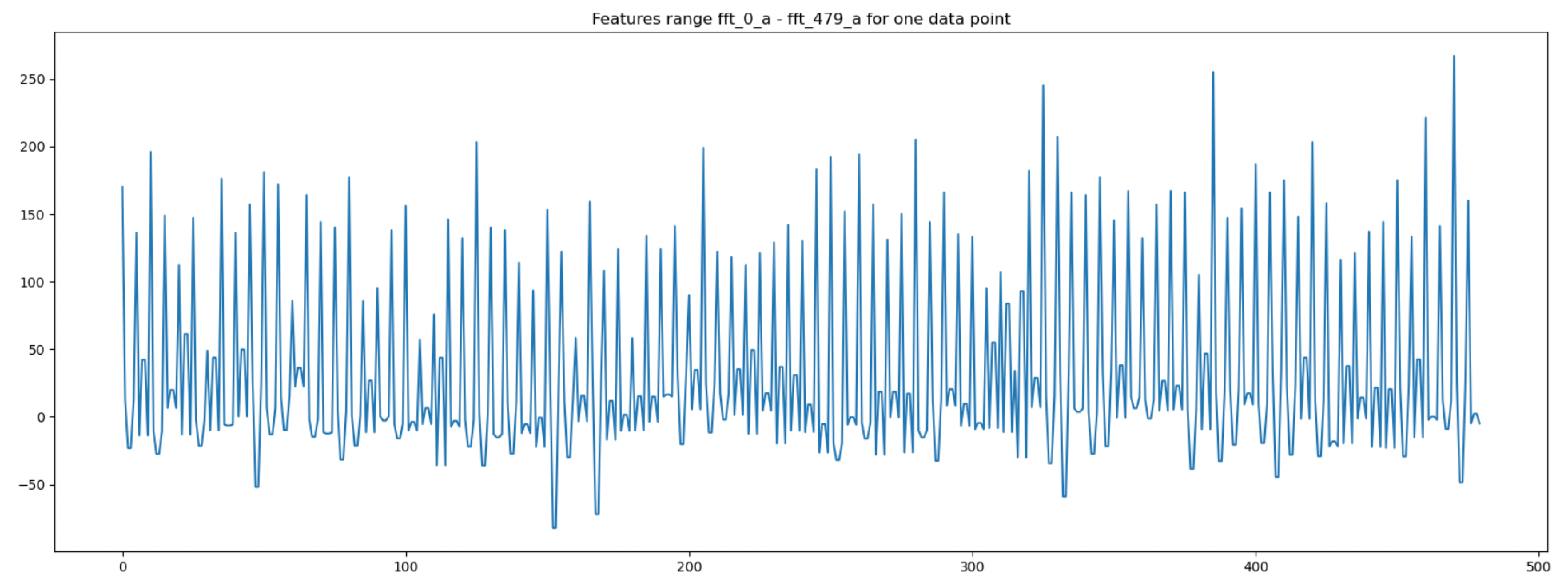
- 24 EEG recordings were systematically split into 100 segments for diverse pattern capture.
- Specialized class extracts min, max, mean, and std from each segment.
- Maintained consistent segment lengths while uncovering vital frequency-based insights, using a fast-fourier transformer.


EEG Segment 24
EEG Data
Amplitude
Time
60
40
20
0
−20
0
20
40
60
80
100
120
140


EEG Segment 19
EEG Data
Amplitude
Time
100
50
0
−50
−100
−150
0
20
40
60
80
100
120
140

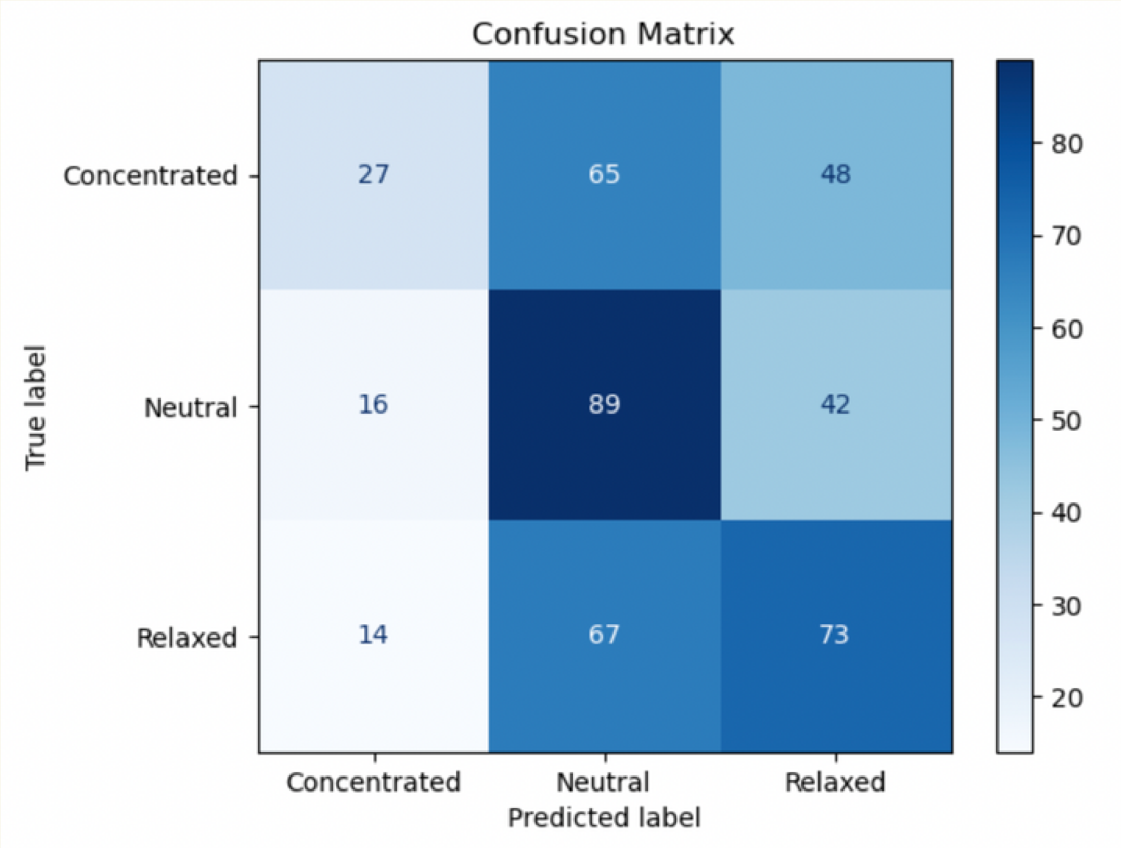

EEG Segment 6
EEG Data
Amplitude
Time
60
50
40
30
20
10
0
−10
0
20
40
60
80
100
120
140


EEG Segment 1
EEG Data
Amplitude
Time
100
80
60
40
20
0
20
40
60
80
100
120
140


Features range fft_0_a - fft_479_a for one data point
250
200
150
100
50
0
−50
0
100
200
300
400
500

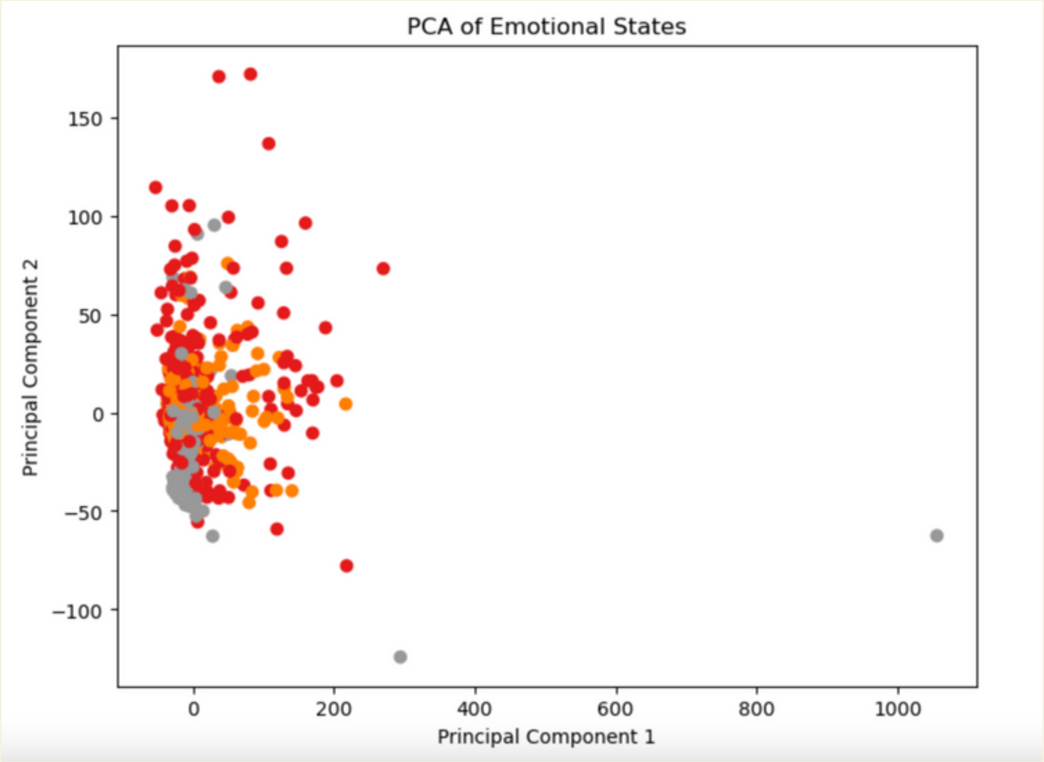
BASE CLASSIFICATION MODEL

- My first model was a K-NN model, which gave me an accuracy of 0.43



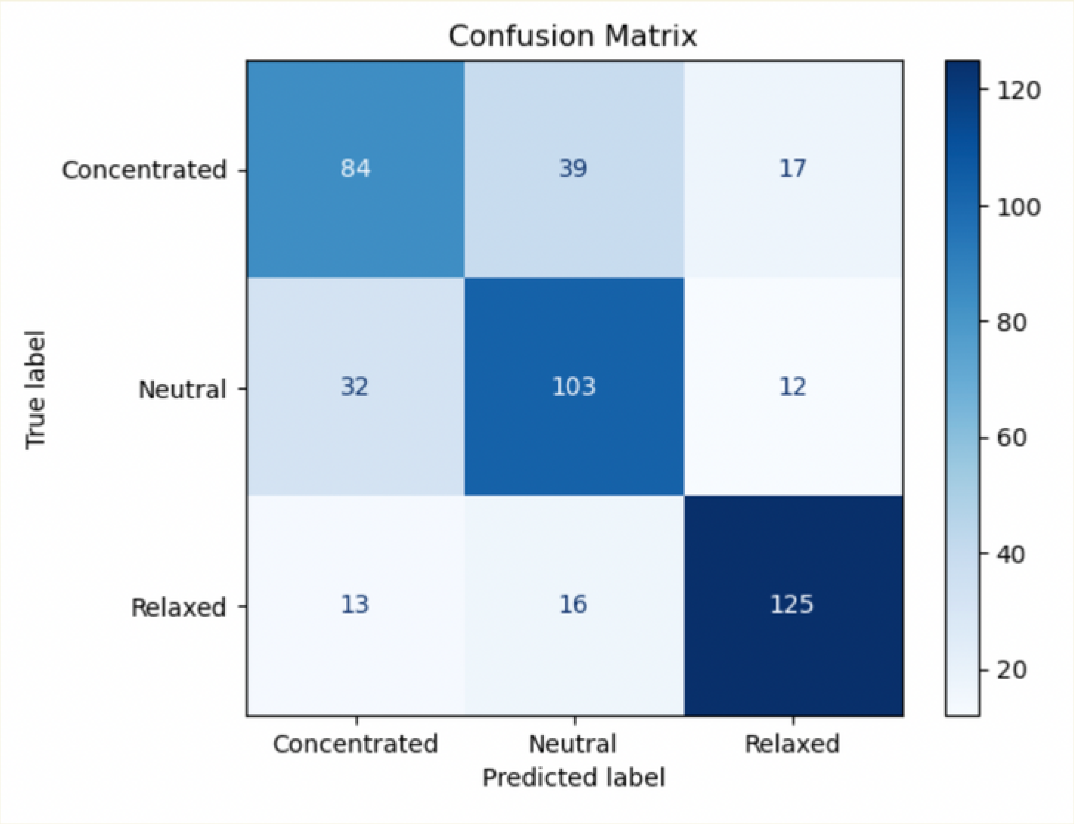
PRINCIPAL COMPONENT ANALYSIS

- A principal component analysis revealed that the first two components from my dataset are the most relevant to the model



FINAL CLASSIFICATION MODEL

- The final model was an XGBoost Model with the dimensionality reduction from the PCA, which gave me an accuracy of 0.70



BUSINESS RECOMMENDATIONS

- Prototype the model for integration into neuromotor interfaces, enhancing brain imaging data interpretation for improved interface responsiveness.
- Collaborate with biomedical researchers to leverage the model for neurological disorder studies, potentially advancing medical responses.
- Explore applications in personalized experiences, tailoring interfaces or services based on real-time mental states inferred from EEG signals.

FUTURE DATA IMPROVEMENTS

- Investigate signal amplification techniques or preprocessing methods to enhance the strength of EEG signals, potentially improving model sensitivity.
- Expand the dataset by incorporating data from a more extensive array of electrodes, providing a more comprehensive representation of brain activity.

FUTURE MODEL IMPROVEMENTS

- Explore additional feature engineering techniques to extract more nuanced information from EEG signals, potentially uncovering hidden patterns.
- Experiment with more complex model architectures, such as recurrent neural networks (RNNs) or attention mechanisms, to capture temporal dependencies in EEG data more effectively.

THANK YOU