Weekly Work Report 11/15/2024

**This Week:**

* **Literature review**

Shin, Y., Choi, D., Park, H., Lee, M., Hong, T., & Koo, C. (2024). Impact of Heat Stress on Individual Cognitive States: Utilizing EEG Metrics in Immersive VR–Based Construction Safety Training. *Journal of Management in Engineering, 40*(6), Article 6076. <https://doi.org/10.1061/JMENEA.MEENG-6076>

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The theta/beta ratio (TBR) in the frontal area is inversely related to attention control and serves as a key biomarker for its assessment. Theta/beta ratio recorded from frontal regions was considered a valuable biomarker of attentional control, indicating a negative relationship with attentional control.

**Individuals with higher theta/beta ratios tended to have lower attentional control.**

Employed unsupervised learning via **K-means** clustering to categorize training EEG signals into three distinct clusters, each representing a different level of attention. (training, exam(experiment))

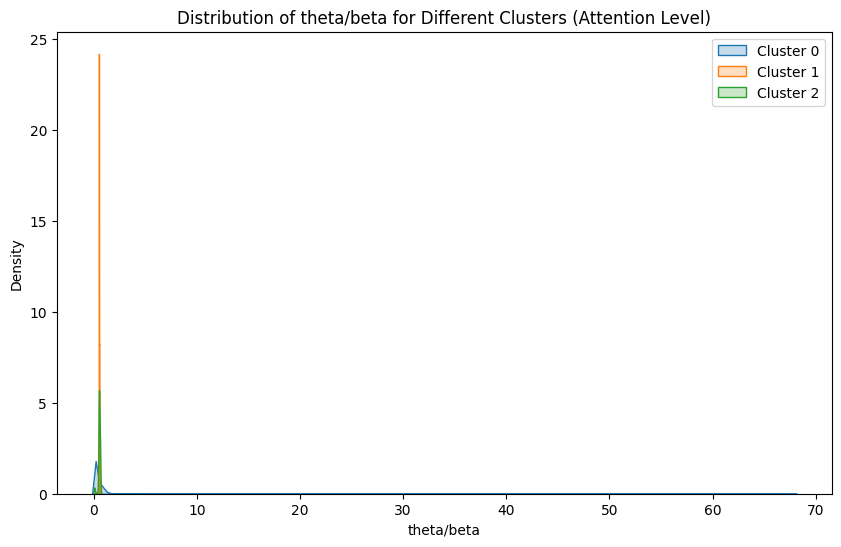
2 clusters? Print the mean, std, in each cluster for 2 or 3 clusters

Training: Attention

Exam: Relax

Distribution of ratio in Training and Exam dataset

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Description automatically generated**

**Features**

* power of frequency bands + **'theta/beta'**
* ['delta', 'theta', 'sigma', 'beta', 'mid\_beta', 'high\_beta', 'low\_gamma', 'theta/beta'] Attention, same models
* ['delta', 'theta', 'sigma', 'beta', 'mid\_beta', 'high\_beta', 'low\_gamma'] Attention, same models
* Compare these two result by using same models, same dataset with 'theta/beta' and without 'theta/beta'

**Labels**

* **0: Baseline, 1: Impasse, 2: Aha, 3: Attention**

**Feature extraction:**

freq\_bands = {

**'delta'**: (0.5, 4),

**'theta'**: (4, 8),

'alpha/mu': (8, 12),

'low\_alpha': (8, 10),

'high\_alpha': (10, 12),

'mu': (9, 12),

**'sigma'**: (12, 16),

**'beta'**: (13, 30),

'low\_beta': (13, 15),

'**mid\_beta'**: (15, 20),

'**high\_beta'**: (20, 30),

**'low\_gamma'**: (30, 50)

}

# Sample rate (adjust as needed)

fs = 125

def calculate\_band\_power(eeg\_signal, freq\_bands, fs):

band\_powers = {}

for band\_name, (low\_freq, high\_freq) in freq\_bands.items():

# Apply FFT to the EEG signal

fft\_values = np.fft.fft(eeg\_signal)

frequencies = np.fft.fftfreq(len(eeg\_signal), 1/fs)

# Find indices corresponding to the frequency band

idx\_band = np.where((frequencies >= low\_freq) & (frequencies <= high\_freq))

# Calculate the power in the frequency band

power = np.sum(np.abs(fft\_values[idx\_band])\*\*2)

band\_powers[band\_name] = power

return **band\_powers**

**Aha:**

A bar of numbers with green and orange squares

Description automatically generated with medium confidence

Impasse

1. Finishlist.csv
   1. **'finishClick'**with Selection: **A (stuck)**
      * From **bt\_finish\_click\_time – 15** to **bt\_finish\_click\_time – 5**
      * 10s

**Attention**

* High attention from k-means clusters derived from **training** EEG signals
* Filter?

**61 subjects**

**Result KNN**

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FCCN

ROC Curve

* RF

A graph of a function

Description automatically generated with medium confidence

1. XGBoost

A graph of a function

Description automatically generated

**Next Week:**

* Complete processing of additional signals, including EDA and pupil data.
* Utilize the **Spectrogram** approach to convert EEG signals into 2D images and extract spectrogram features.
* Consolidate all information and present results in a single table.
* Compare findings to other research papers using the same dataset.
* Analyze different time windows (1s, 3s, 5s, 8s) based on literature review.
* Another ROC, imbalanced dataset

**This Month:**

* Compare Aha!/Impasse/Attention classification using
  + physiology signals
  + EEG
  + physiology signals + EEG

**Final Goal:**

* Explore the dynamics of **Attention**, **Impasse**, and the **"Aha!"** moment.