Weekly Work Report 10/11/2024

**Response to Feedback from Last Week:**

* Plot the precision-recall curve for classifying Aha! Moments versus non-Aha! Moments.
* Perform N-fold validation for both positive and negative signals.
* Evaluate different time window sizes.
* Incorporate additional frequency bands into the features and analyze the outcomes.

What did I do?

* Introduced **new frequency bands as features** for training the classification model on positive (Aha! Moment) and negative (non-Aha! Moment) signals.
* Conducted classification between **positive (Aha! Moment) and negative (non-Aha! Moment) signals**.
* Evaluated various time window sizes (**1s, 3s, 5s and 8s**)
* Performed **k-fold Cross-Validation**for each model.
* Plotted **precision-recall curves** for each model.

EEG Frequency bands

* **Gamma** (30-80 Hz)
  + Low Gamma (30 - 50 Hz): Plays a role in sensory processing and higher cognitive functions; often seen during focused attention.
* **Beta** (13-30 Hz): Strongest in the frontocentral regions.
  + Beta 1 (13–15 Hz)
  + Beta 2 (15–20 Hz)
  + Beta 3 (20–30 Hz)
* **SMR** (13-15 Hz): Sensorimotor rhythm over the sensorimotor cortex. SMR typically decreases in amplitude when the corresponding sensory or motor areas are activated.
* **Alpha** (8-12 Hz): Strongest in the occipital areas at the back of the scalp (visual cortex). Alpha power is assumed to be inversely related to cortical activation. Alpha power could be regarded as an index of top-down processing, representing a mechanism for increasing the signal-to-noise ratio.
* **Mu** (9-12 Hz): The mu rhythm can be found in the frontoparietal region: over the motor cortex, in a band approximately from ear to ear.
* **Theta** (4-8 Hz): Midline theta is usually maximal in the frontal or fronto-central regions.
* **Delta** (0.5-4 Hz): Strongest in frontal areas. Inhibition of the sensory afferences (Harmony, 2013).

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)

}

Label Setting:

* Aha! Moment
  + Defined from TagHandMenuPumpTime - 12s to TagHandMenuPumpTime - 2s.
* Non-Aha! Moment
  + Derived from filtered baseline data.

Features:

* Compute the max, min, standard deviation, and mean for each channel.
* Calculate power across each frequency band.
* [ "FP1\_min", "FP1\_max", "FP1\_std", "FP1\_mean",

"FP2\_min", "FP2\_max", "FP2\_std", "FP2\_mean",

"C3\_min", "C3\_max", "C3\_std", "C3\_mean",

"C4\_min", "C4\_max", "C4\_std", "C4\_mean",

"P7\_min", "P7\_max", "P7\_std", "P7\_mean",

"P8\_min", "P8\_max", "P8\_std", "P8\_mean",

"O1\_min", "O1\_max", "O1\_std", "O1\_mean",

"O2\_min", "O2\_max", "O2\_std", "O2\_mean",

"F7\_min", "F7\_max", "F7\_std", "F7\_mean",

"F8\_min", "F8\_max", "F8\_std", "F8\_mean",

"F3\_min", "F3\_max", "F3\_std", "F3\_mean",

"F4\_min", "F4\_max", "F4\_std", "F4\_mean",

"T7\_min", "T7\_max", "T7\_std", "T7\_mean",

"T8\_min", "T8\_max", "T8\_std", "T8\_mean",

"P3\_min", "P3\_max", "P3\_std", "P3\_mean",

"P4\_min", "P4\_max", "P4\_std", "P4\_mean",

"delta\_min", "delta\_max", "delta\_std", "delta\_mean",

"theta\_min", "theta\_max", "theta\_std", "theta\_mean",

"alpha/mu\_min", "alpha/mu\_max", "alpha/mu\_std", "alpha/mu\_mean",

"low\_alpha\_min", "low\_alpha\_max", "low\_alpha\_std", "low\_alpha\_mean",

"high\_alpha\_min", "high\_alpha\_max", "high\_alpha\_std", "high\_alpha\_mean",

"mu\_min", "mu\_max", "mu\_std", "mu\_mean",

"sigma\_min", "sigma\_max", "sigma\_std", "sigma\_mean",

"beta\_min", "beta\_max", "beta\_std", "beta\_mean",

"low\_beta\_min", "low\_beta\_max", "low\_beta\_std", "low\_beta\_mean",

"mid\_beta\_min", "mid\_beta\_max", "mid\_beta\_std", "mid\_beta\_mean",

"high\_beta\_min", "high\_beta\_max", "high\_beta\_std", "high\_beta\_mean",

"low\_gamma\_min", "low\_gamma\_max", "low\_gamma\_std", "low\_gamma\_mean"]

Classification Methods:

* K-Nearest Neighbors (KNN)
* Random Forest (RF)
* XGBoost

Results:

* Precision-recall curves for each time window size.

A graph of a graph

Description automatically generated

A graph of a graph

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A graph of a graph

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A graph with a line

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A graph with a line

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A graph with a line going up

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A graph of a graph

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A graph of a window size

Description automatically generated

A graph with a line

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A graph with a line

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* Summary of the results.

A graph with different colored lines

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Next Week:

* Conduct a literature review on labeling, brain structure, and functionality.
* Begin processing additional signals, including EDA and pupil data.
* Perform classification by adding more subjects' EEG data.
* Explore results using different models.
* 2nd experiment: All the negative samples, just for validation.
* AUC
* Architecture

Final Goal:

* Explore the dynamics of **attention**, stuck states, and the **"Aha!" moment**.
* NN classifier