EEG-based Classification of Cognitive Impairment

Methodology

- Baseline with simple feature selection: Regional, vectors
- Baseline with simple methods: Random forest, SVM
- Evaluation pipeline: CV, recall, F1, binary classification

- Improve
- Interpretability

Feature extraction (1/3)

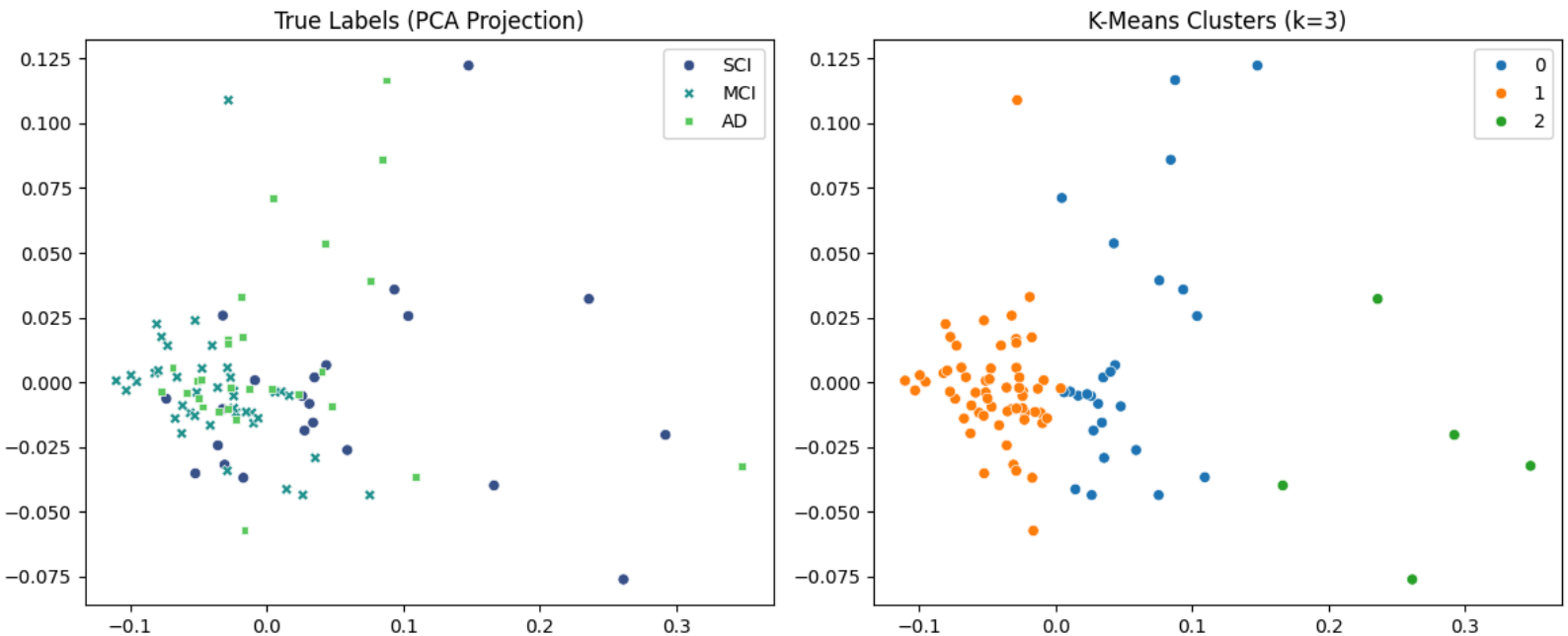

Figure 1: PCA of true labels vs K-Means using the alpha band and regional feature selection (30 features). Silhouette=0.392, ARI=0.107

Feature extraction (2/3)

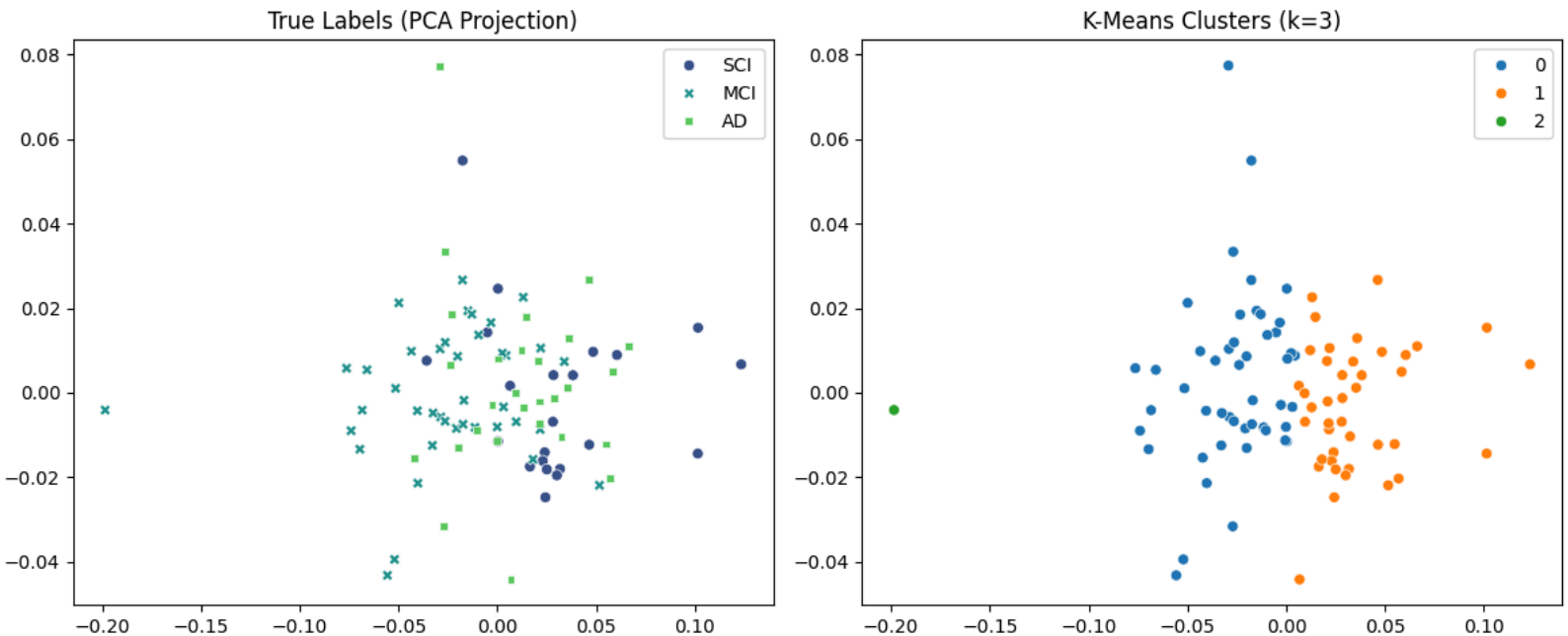

Figure 2: PCA of true labels vs K-Means using the theta band and vector feature selection. Silhouette=0.249, ARI=0.180

Feature extraction (3/3)

Regional: Mean on the rows: 30 features.

Vector: Upper diagonal, $\frac{30 \times 29}{2} = 435$ features.

Model selection

Strategy	Band	Selection	Model	Balanced Accuracy
Regional	Alpha	ANOVA (k=20)	Random Forest	**58.22%**
Vector	Beta	ANOVA (k=20)	Random Forest	56.89%
Regional	Alpha	None	Random Forest	52.78%

Table 1: Classification performance (nested CV)

Evaluation (1/2)

Strategy	Band	Selection	Model	Accuracy
Regional	Alpha	ANOVA (k=10)	Random Forest	**65.56%**
Vector	Alpha	None	SVM	61.11%
Vector	Alpha	ANOVA (k=50)	Random Forest	61.11%

Table 2: Classification performance with bad evaluation

ANOVA used on train and test set, high variance.

Balanced accuracy

$$\text{Accuracy} = \frac{\text{Correct}}{\text{Total}}$$

$$\text{Balanced accuracy} = \frac{1}{3}\left(\frac{\text{Correct MCI}}{\text{Total MCI}} + \frac{\text{Correct SCI}}{\text{Total SCI}} + \frac{\text{Correct AD}}{\text{Total AD}}\right)$$

Evaluation (2/2)

Metrics:

- Accuracy
- Balanced accuracy
- Precision
- Recall
- F1

Methods:

- LOO
- Mean, std

Interpretability

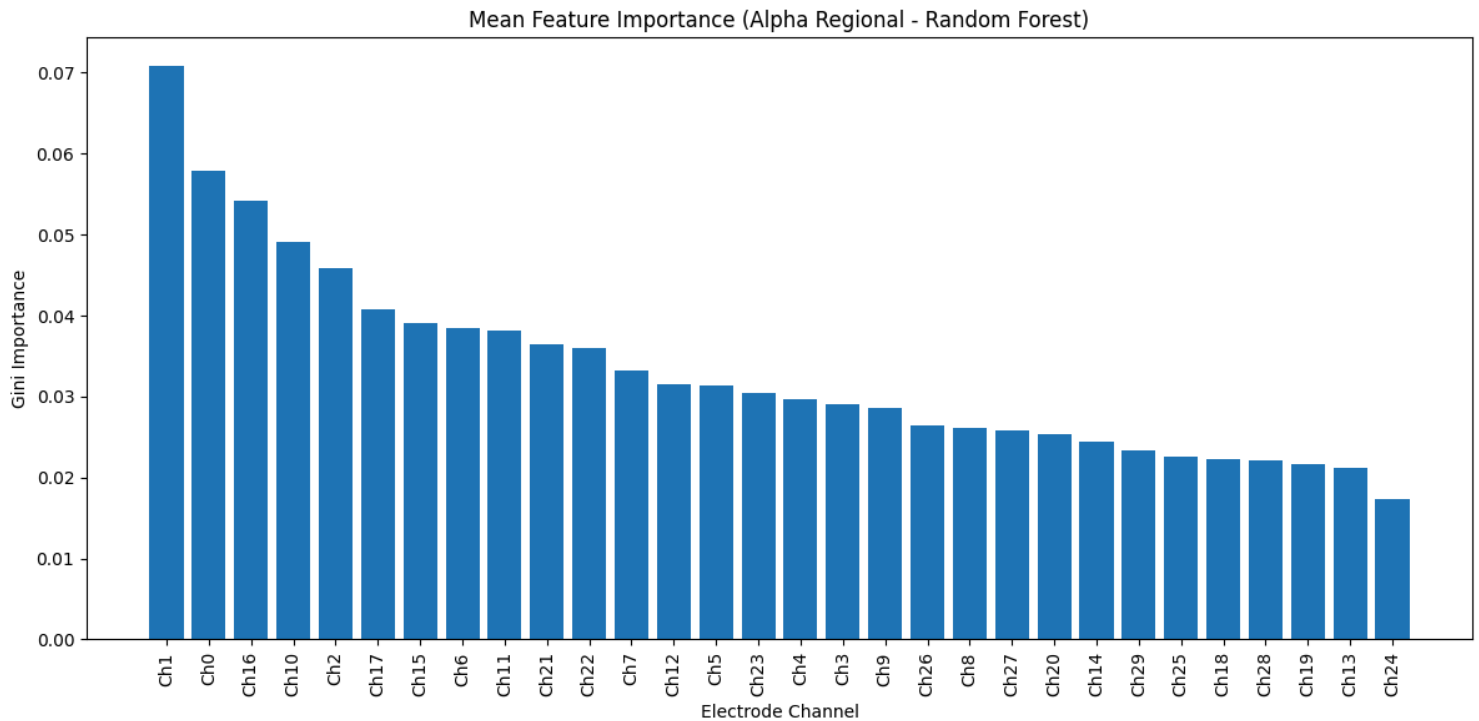

Figure 3: Most important electrodes when looking at the alpha band seems to be at the front.

Binary classification: AD vs SCI+MCI

- **Accuracy: 71.56%**
- **Balanced Accuracy:** 58.67%

$\rightarrow$ *Continuous transition between SCI and MCI?*

Next

Improvements

- Test graph metrics.
- Test late fusion.
- Look for better feature selection.

Interpretability

- Graphs
- Investigate MCI heterogeneity.

Failed experiments

- Use a sample of 28 SCI instead of all 40: on RF with the regional features and alpha band, it performed worse (51% acc vs 62%).
- Mutual information feature selection performs worse than ANOVA: on RF with the regional features and alpha band (53% acc vs 62%).
- Tree-based feature selection performs worse than ANOVA: on RF with the regional features and alpha band (60% vs 62%).