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# DIMENSIONALITY REDUCTION & FREQUENCY BIN OPTIMIZATION TO IMPROVE A RIEMANNIAN-BASED CLASSIFICATION PIPELINE

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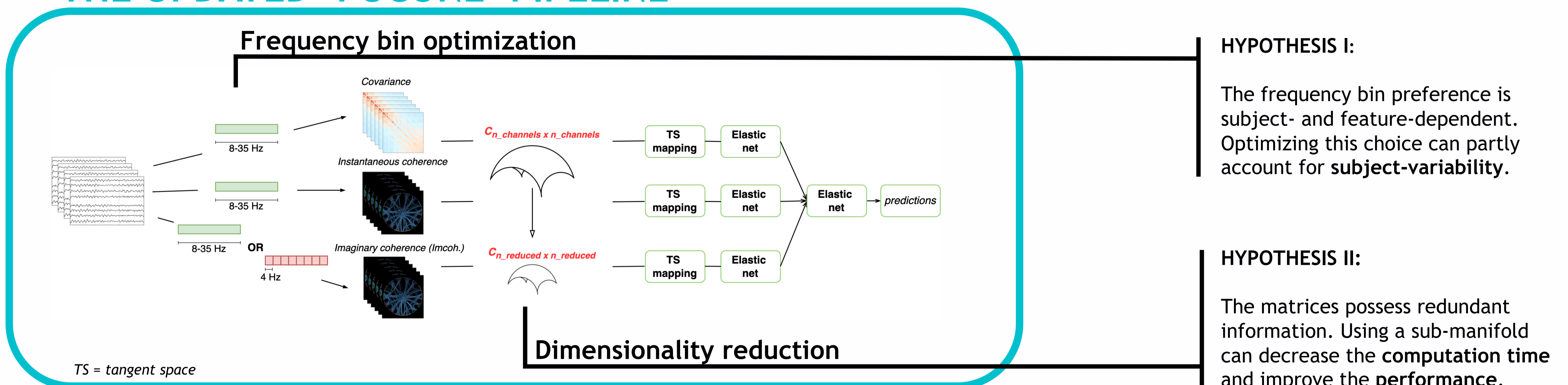
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**Subject variability** and **BCI illiteracy** pose a challenge to the BCI domain. To tackle this, the field has taken a turn towards **Riemannian geometry**, which has been shown to reach state-of-the-art performance. This promising mathematical concept is applicable in this field as the **covariance matrices** lay on a Riemannian manifold. This idea is exploited by combining Riemannian geometry with **functional connectivity** in a 'Functional Connectivity Ensemble' (FUCONE) in [1] with the aim to improve the performance of motor imagery (MI) BCI. FUCONE showed promising results, but this multi-step classification process also holds room for improvement. In this work, we focus on two aspects of the pipeline: **the choice of frequency band** and **dimensionality reduction** of the feature space.

## RIEMANNIAN GEOMETRY

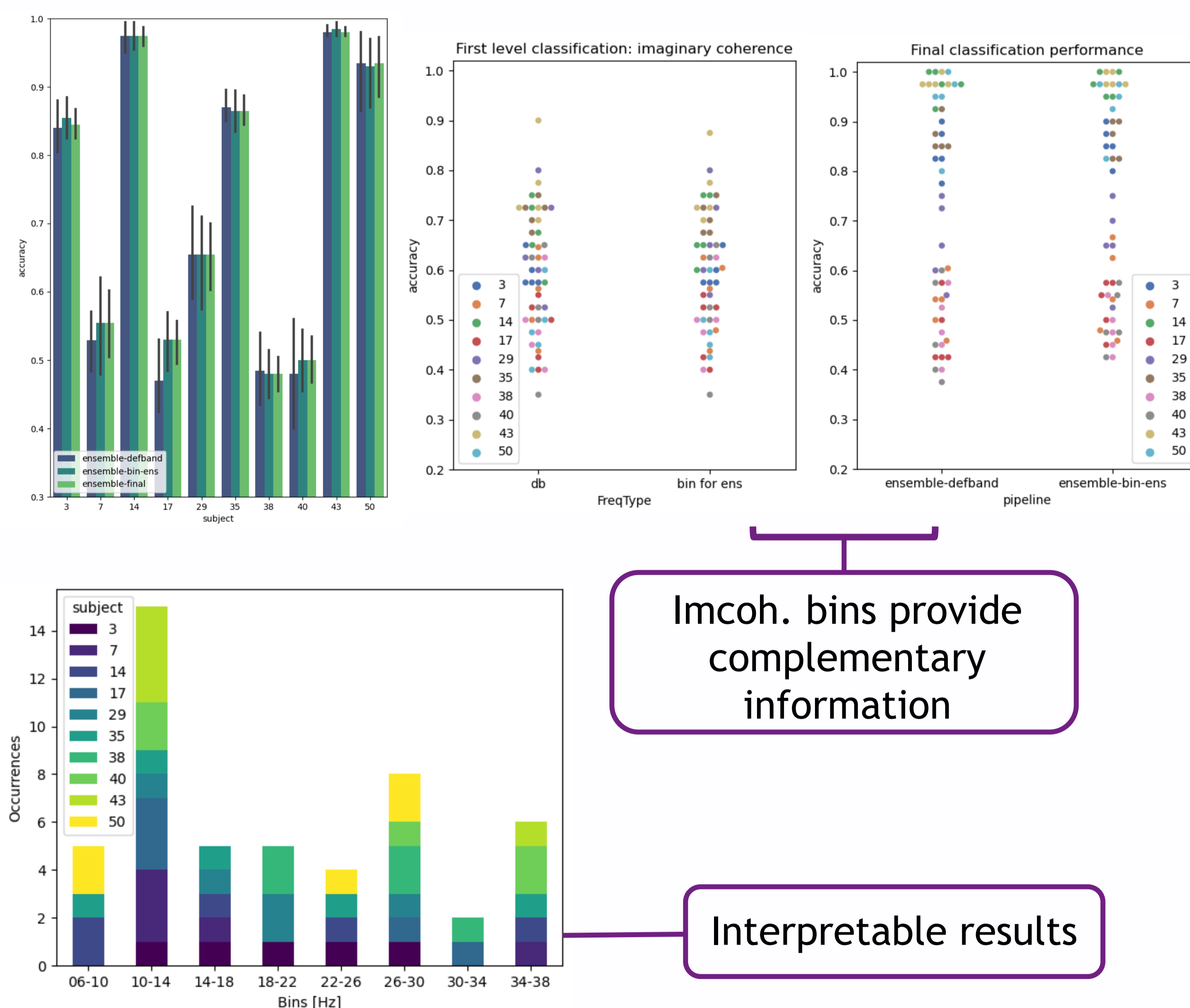
This promising mathematical concept is applicable in the field of BCI as the **covariance matrices** lay on a Riemannian manifold, a curved space. This manifold enables to extract **structural information** that is embedded in the matrices. By mapping the matrices onto the **tangent space** (an Euclidean space), traditional classification methods can be applied, such as LDA and SVM.

## THE UPDATED 'FUCONE' PIPELINE



### I - Frequency bin optimization

### II - Dimensionality reduction



## NEXT STEPS

- Introduce **multi-modal data**
- Take **feature/subject bin-preferences** into account
- More extensive bin/metric combinations

- Further **hyperparameter tuning** (focus on Riemannian PCA)
- Improve **interpretability** by analyzing the projection matrix

## REFERENCES

[1] M.-C. Corsi et al. "Functional Connectivity Ensemble Method to Enhance BCI Performance (FUCONE)". In: IEEE Trans. Biomed. Eng. 69.9 (2022), pp. 2826-2838. doi: 10.1109/TBME.2022.3154885.