

Supplementary Material for GeoHSAF

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A. Reconstruction Errors from Logarithm Mapping

Table 1 presents the mean reconstruction errors in terms of mean absolute error (MAE), Hausdorff distance, and Chamfer distance for normal controls (NC) and Alzheimer’s Disease (AD) subjects from the ADNI dataset. We project each shape to the tangent space at their mean via the logarithm mapping and reconstruct the projected shapes back in the shape space via the exponential mapping. We then compute the error between the ground truth (GT) and the reconstructed shapes. The goal of this experiment is to investigate the quality of the projections via the logarithm mapping. In table 1, we can observe extremely small error values across all metrics and for both groups, confirming the quality of the projections. We observe similar results for the other two datasets (AIBL and OASIS).

We also present in figure 1 reconstructed shapes over time for one AD subject and one NC subject for visual evaluation. The top row corresponds to the GT shapes while the bottom row corresponds to the reconstructed shapes. We can notice the quality of the reconstructions which confirms the extremely low error values shown in table 1.

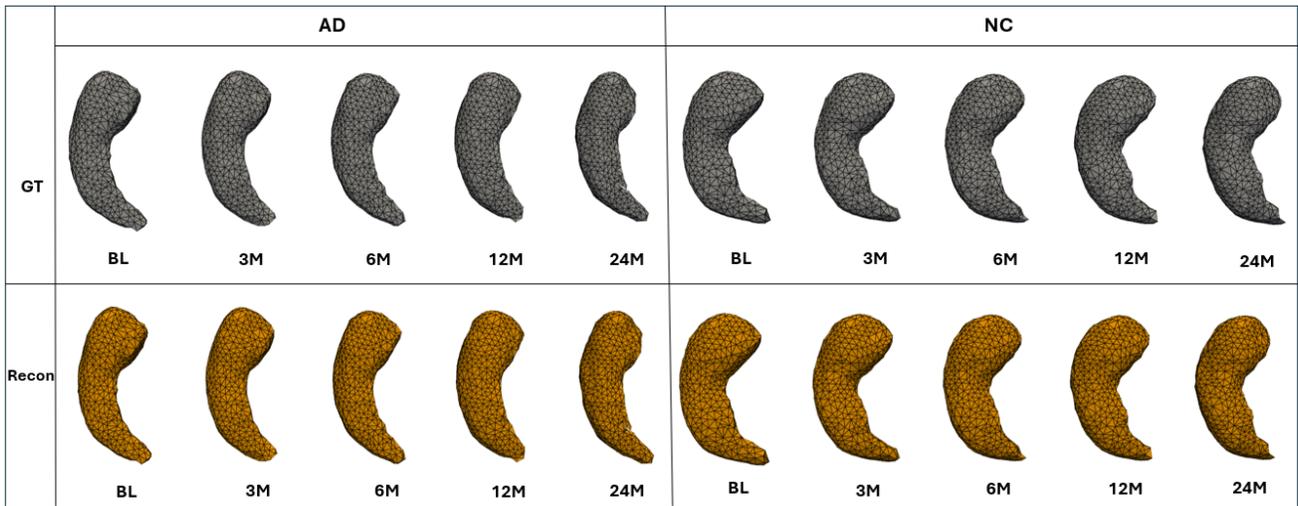


Figure 1. Visualization of reconstructed shapes over time for one AD subject (left column) and one NC subject (right column). Each subject has multiple scans across different timepoints. 'GT' and 'Recon' refer to the ground truth and reconstructed shapes, respectively. The top row shows the ground truth shapes at each timepoint, and the bottom row shows the corresponding reconstructions. 'BL' denotes baseline (the first scan), and 'M' indicates months since baseline. Reconstructed shapes are shown in orange.

Group	MAE ($\times 10^{-18}$)	Hausdorff ($\times 10^{-17}$)	Chamfer ($\times 10^{-35}$)
NC	1.85202 ± 1.036334	1.54366 ± 0.47135	6.31021 ± 5.77717
AD	2.11778 ± 1.06046	1.67866 ± 0.51612	7.61111 ± 5.97806

Table 1. Mean reconstruction error between the ground truth shapes and their reconstructions for the ADNI dataset. The reconstructions are obtained via exponential mapping after projecting the shapes to the tangent space at their mean via logarithm mapping.

B. Reconstruction Errors from Principal Geodesic Analysis (PGA)

Figure 2 presents the mean absolute reconstruction error on both train and test samples from selected principal directions during PGA. Each point represents the mean MAEs corresponding to a given amount of variance explained by the principal directions. Results are shown for both the AD and NC groups from the ADNI dataset, with similar trends observed in the OASIS and AIBL datasets. A consistent decline in reconstruction error is observed as the explained variance increases, with the lowest error typically achieved when retaining components that explain more than 90% of the variance. Based on this, we retain principal directions that yield the lowest reconstruction error while explaining between 90% and 95% of the total variance.

C. PGA Variance on Classification Performance for OASIS and AIBL Datasets

In figure 3, we show for AIBL and OASIS datasets, the plots of classification performance (ACC and AUC) against the explained variance from principal geodesic Analysis. We can similarly observe for the two datasets that the highest classification performance is achieved by retaining between 90% - 95% variations in the shapes data.

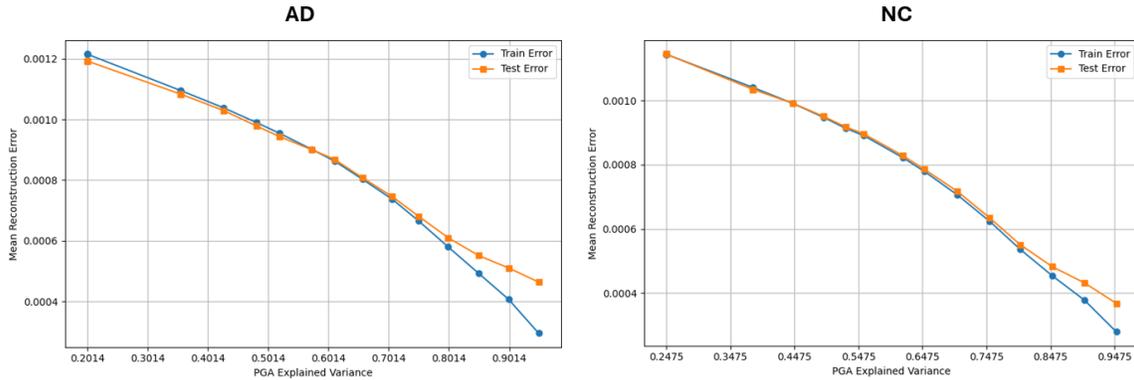


Figure 2. Figure plots of the MAE against PGA explained variance on AD and NC shapes for the ANDI dataset. The variances are explained by the principal geodesic directions.

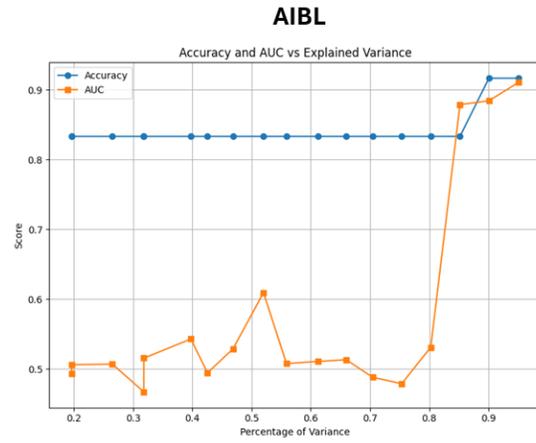
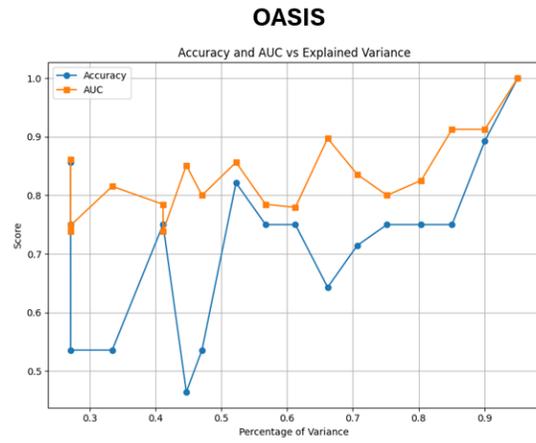


Figure 3. Figure plots of PGA explained variance versus classification performance for OASIS and AIBL datasets.