Supplementary

1 How Well Is 3D Information Encoded in the Latent Space of the DAE?

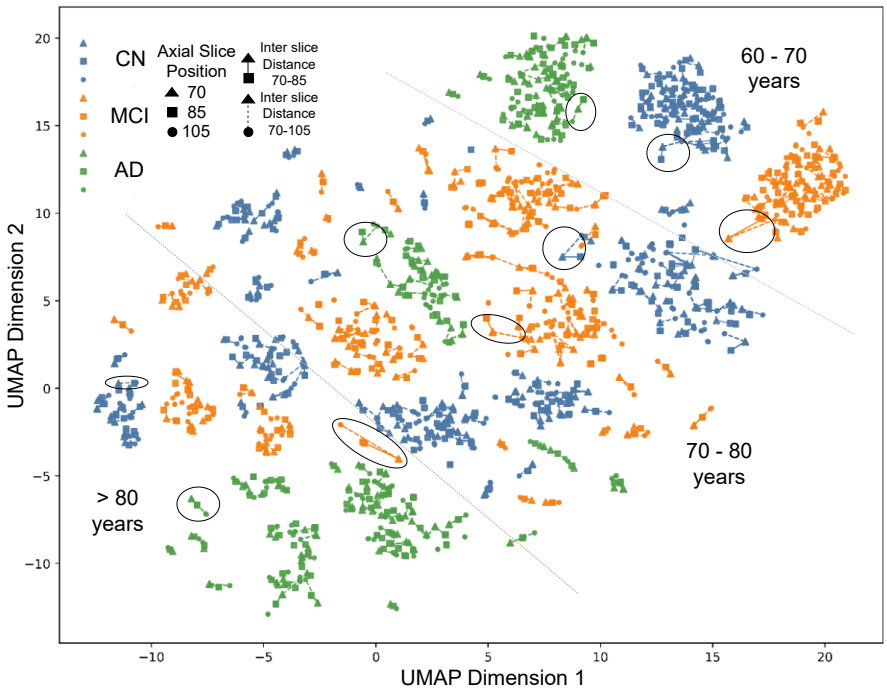

Figure 1: UMAP plot of the latent representations (z) of three axial sections from all the volumes of ADNI *Test Set*. The three slices- 70^{th}, 85^{th} and 105^{th} along the axial plane are denoted by triangle, square and circle respectively. The distance from the 70^{th} to 85^{th} and 70^{th} to 105^{th} are denoted by straight and dashed line respectively for all the volumes. This plot represents that the spatial location of the 3D volumes are meaningfully embedded within the latent representational space.

Figure 1 illustrates the organization of axial slices from 3D volumes at different locations (70^{th}, 85^{th}, and 105^{th}) in the latent representational space of the DAE. Across the entire embedding, axial slices originating from the same 3D volume are spatially co-located, indicating consistent encoding of volumetric information.

For each volume, the latent-space distances between the 70^{th} and 85^{th} slices, and between the 70^{th} and 105^{th} slices, are visualized using solid and dashed lines, respectively. Distances corresponding to axially closer slices (solid lines) are consistently smaller than those between axially distant slices (dashed lines). This relationship is observed across disease categories (CN, MCI, and AD, shown in blue, orange, and green) as well as across different age groups.

The spatial co-location of slices from the same volume, together with higher-level grouping by disease category and age, indicates that the latent representational space effectively encodes both subject-specific 3D structural information and progression-related characteristics. Overall, these results suggest that the DAE latent space preserves volumetric coherence while capturing meaningful disease- and age-related variations.