2. Hierarchical Clustering and Phenotype Discovery in ADNI Using Unsupervised Learning

Target journals:

- *Expert Systems with Applications* (Elsevier, Scopus + Q1)
- *Pattern Recognition Letters* (Scopus + SCI)
- *Brain Informatics* (Springer, Scopus)

Novel angle:
Unsupervised stratification of Alzheimer's subtypes based on latent biomarker space instead of labeled diagnosis.

Methods:

- PCA, t-SNE, UMAP projection
- Clustering (K-means, Agglomerative, DBSCAN, GMM)
- Cluster validation (Silhouette, Davies-Bouldin, CH-index)
- Post-hoc clinical interpretation (cluster-wise MMSE drop, MRI atrophy pattern)

Outcome:
Discovery of **3–4 clinically meaningful patient phenotypes** (e.g., amnestic vs executive vs mixed subtype).
