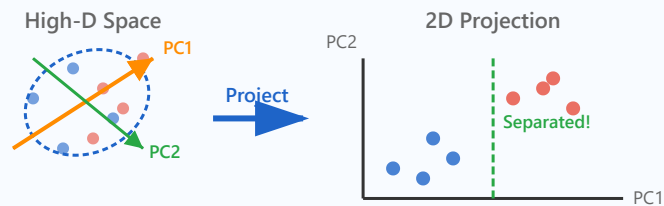


# Dimensionality Reduction

## PCA

Principal Component Analysis - linear transformation preserving maximum variance

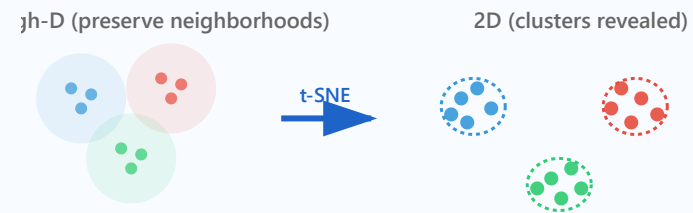


### Clinical Applications:

- Gene expression clustering
- Quality control visualization
- Batch effect detection

## t-SNE

t-Distributed Stochastic Neighbor Embedding - nonlinear visualization method



### Clinical Applications:

- Single-cell RNA-seq visualization
- Patient subtype discovery
- Exploratory data analysis

## UMAP

Uniform Manifold Approximation - faster than t-SNE, preserves global structure

## Autoencoders

Deep learning compression - learns nonlinear representations

High-D Manifold



UMAP  
*fast & global*

2D (structure preserved)



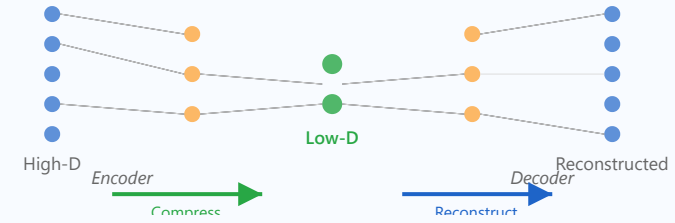
#### Clinical Applications:

- Large dataset visualization
- Multimodal data integration
- Trajectory inference

Input

Latent Space

Output



#### Clinical Applications:

- Feature extraction for prediction
- Denoising medical images
- Anomaly detection