DTW-based Clustering

Time Series Clustering with DTW Distance Metric

Clustering Methods

K-medoids

Better than K-means (pairwise distances)

Hierarchical

DTW linkage for dendrogram

DBA

DTW Barycenter Averaging for centroids

Computational Cost

$$O(n^2m^2)$$

n series × length m

Speed Approximations

- FastDTW
- PrunedDTW

DTW Clustering Workflow

1. Compute DTW distance matrix for all pairs
2. Apply clustering algorithm (K-medoids/Hierarchical)
3. Compute cluster centroids using DBA
4. Iterate until convergence or max iterations
5. Evaluate clustering quality with silhouette score

Key Applications

- Gesture Recognition
- ECG Analysis
- Stock Patterns
- Speech Recognition

DTW Clustering: Calculation Example

Step-by-step computation with 3 time series

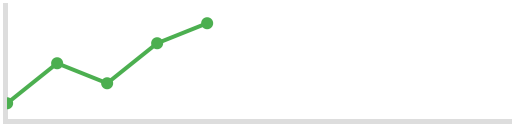
Input Time Series

Series A

[1, 2, 3, 4, 5]

Series B

[1, 3, 2, 4, 5]



Series C

[5, 4, 3, 2, 1]

Step 1: Compute DTW Distance Matrix

	A	B	C
A	0.0	2.4	8.9
B	2.4	0.0	9.2
C	8.9	9.2	0.0

DTW(A,B) = 2.4 < DTW(A,C) = 8.9

Step 2: Apply K-medoids (k=2)

Cluster 1

A B

Medoid: **Series A**

Cluster 2

C

Medoid: **Series C**

Step 3: DBA Centroid for Cluster 1

Average Alignment

Cluster 1 Centroid

[1.0, 2.5, 2.5, 4.0, 5.0]