A Family of Hierarchical Clustering Algorithms based on High-order Dissimilarities

Helena Aidos and Ana Fred

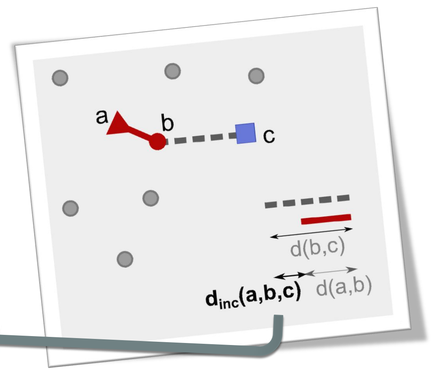
Instituto de Telecomunicações
Instituto Superior Técnico, Universidade de Lisboa, Portugal
{haidos, afred}@lx.it.pt

Dissimilarity increments: definition and distribution

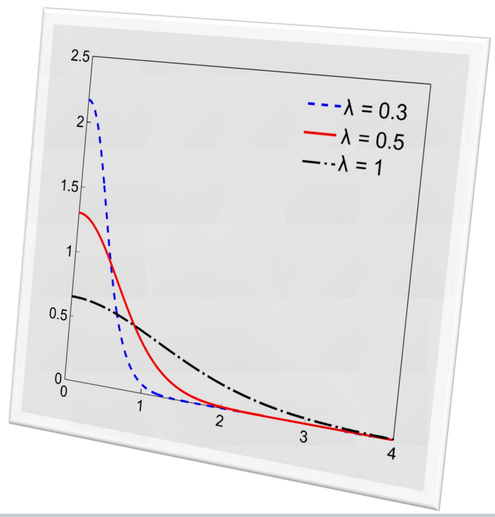
(x_i, x_j, x_k) – triplet of nearest neighbors
- x_j is the nearest neighbor of x_i
- x_k is the nearest neighbor of x_j (different from x_i)

The **dissimilarity increments** between neighboring patterns is defined as

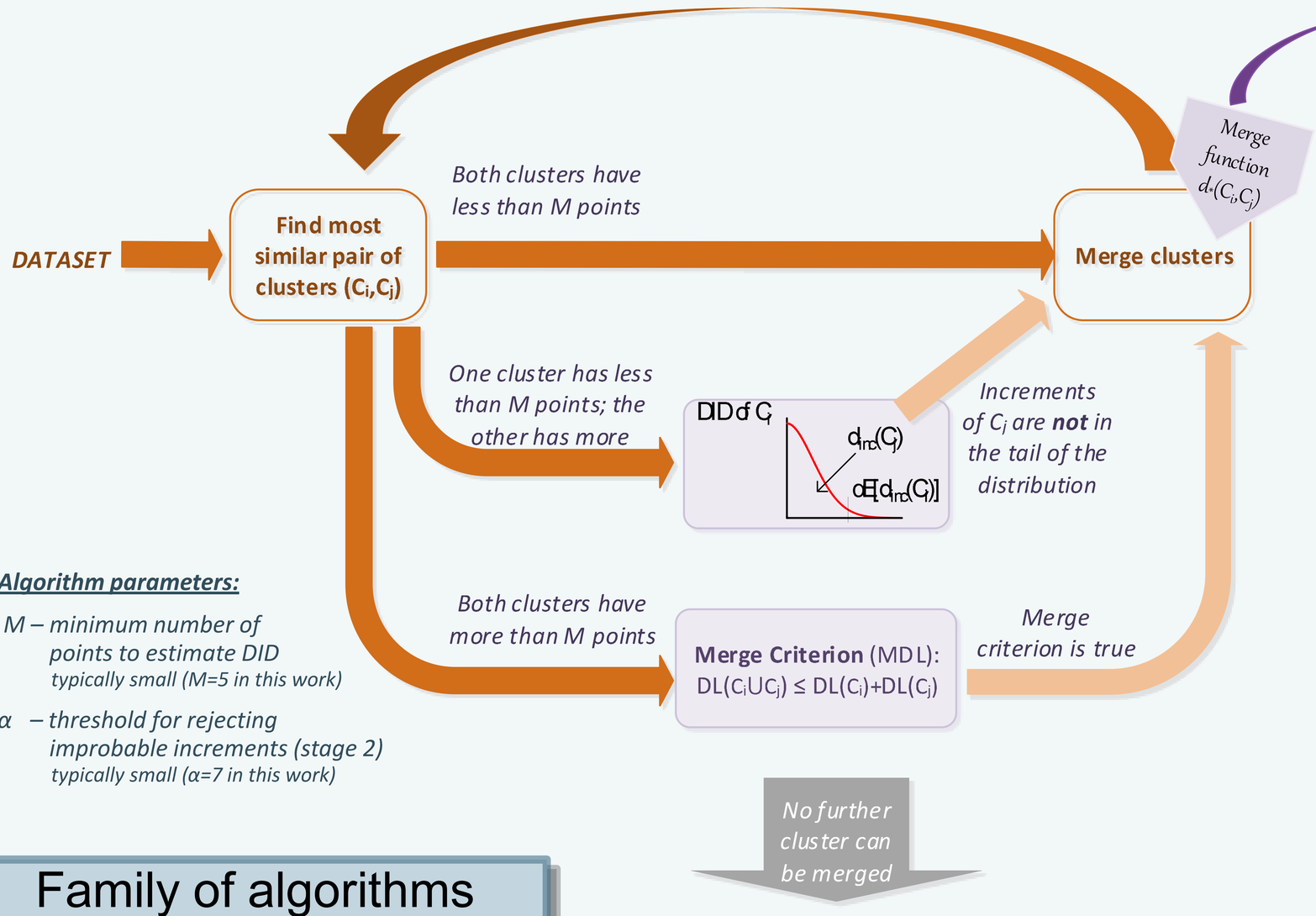
$$d_{inc}(x_i, x_j, x_k) = \left| d(x_i, x_j) - d(x_j, x_k) \right|$$



The **dissimilarity increments distribution (DID)** is a function of the mean value of the dissimilarity increments λ



PROPOSAL: A family of agglomerative hierarchical methods, integrating dissimilarity increments in traditional linkage algorithms



MERGE FUNCTION

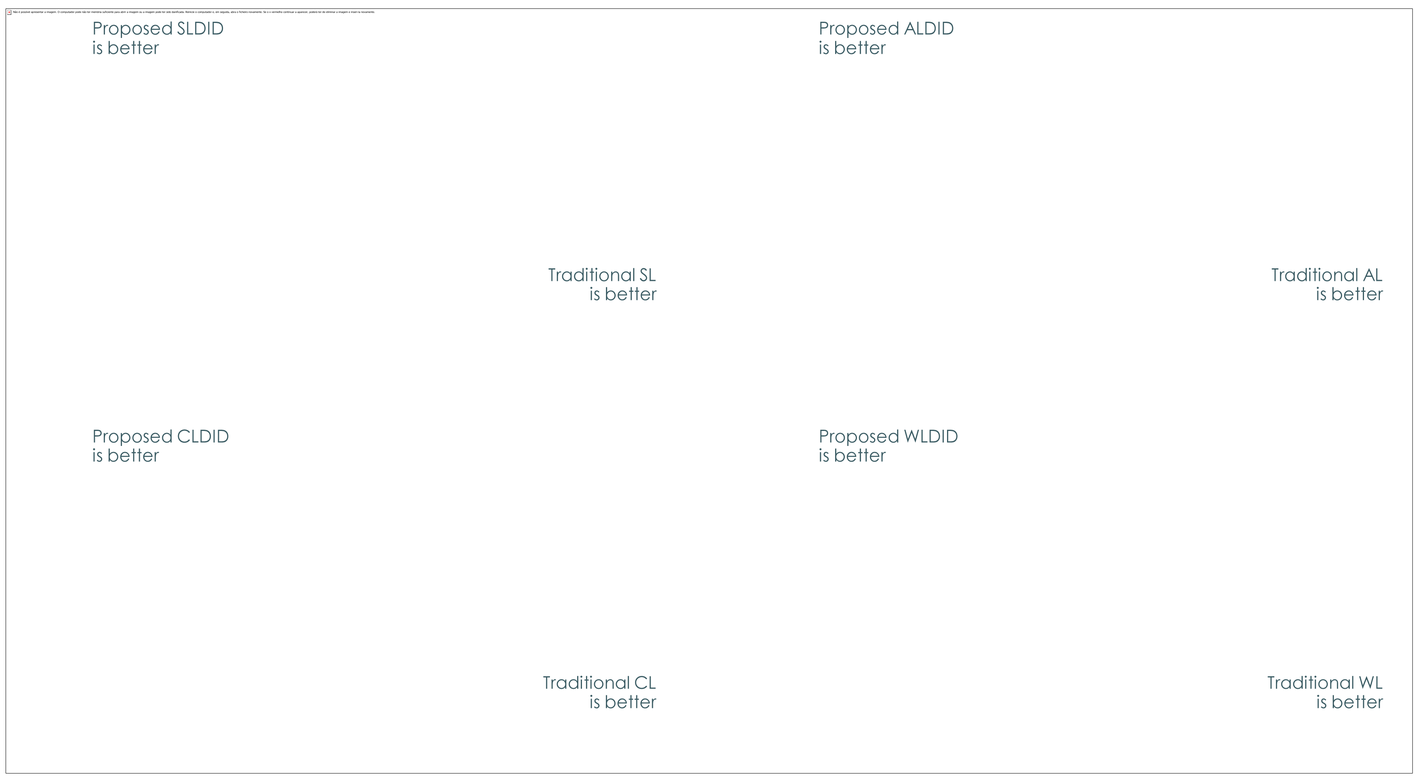
Consider the new formed cluster $C_b = C_i \cup C_j$, obtained by merging C_i and C_j, and C_a is one of the remaining clusters formed in previous steps. Lets consider $|C_i|$ the number of points in cluster C_i

- **SLDID**
$$d_s(C_a, C_b) = \min\{d(C_i, C_a), d(C_j, C_a)\}$$
- **ALDID**
$$d_A(C_a, C_b) = \frac{|C_i|\, d(C_i, C_a) + |C_j|\, d(C_j, C_a)}{|C_i| + |C_j|}$$
- **CLDID**
$$d_c(C_a, C_b) = \max\{d(C_i, C_a), d(C_j, C_a)\}$$
- **WLDID**
$$d_W(C_a, C_b) = \frac{|C_i| + |C_a|}{|C_i| + |C_j| + |C_a|} d(C_i, C_a) + \frac{|C_j| + |C_a|}{|C_i| + |C_j| + |C_a|} d(C_j, C_a) - \frac{|C_a|}{|C_i| + |C_j| + |C_a|} d(C_i, C_j)$$

Family of algorithms

➢ This family of hierarchical agglomerative algorithms is able to **automatically find the number of clusters** using a minimum description length criterion based on the dissimilarity increments distribution (DID)

➢ Each algorithm of the proposed family is able to find classes as unions of clusters, leading to the **identification of internal structures of classes**



DATASETS:
36 real-world datasets from the UCI Machine Learning Repository.

EVALUATION:
Percentage of correctly clustered points assuming that one class can be represented as the union of several clusters.

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