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BISITE
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RESEARCH GROUP

Enhanced Self Organized Dynamic Tree Neural Network

HAIS 2010: 5th International Conference on Hybrid Artificial Intelligence Systems

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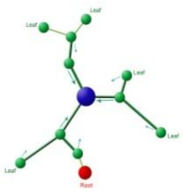


Introduction

- Methods
  - Minimizing objective functions, Hierarchical, probabilistic-based models, Artificial Neural Network
- Establish the number of clusters beforehand or set the number once the algorithm has been completed
- The networks typically require a previous adaptation phase for the neurons.
- Enhanced Self Organized Dynamic Tree neural network (ESODTNN)
  - Eliminates the expansion phase
  - Uses algorithms to detect low density zones and graph theory procedures in order to establish a connection between elements.
  - **Allows to revise the clustering process using hierarchical methods**

Clustering techniques

- Hierarchical methods such as dendrograms do not require a number of clusters up front since they use a graphical representation to determine the number.
- Partition based methods:
  - Number of clusters up front.
    - The k-means algorithm presents problems with atypical points.
    - The PAM method resolves this problem by assigning an existing element as the centroid

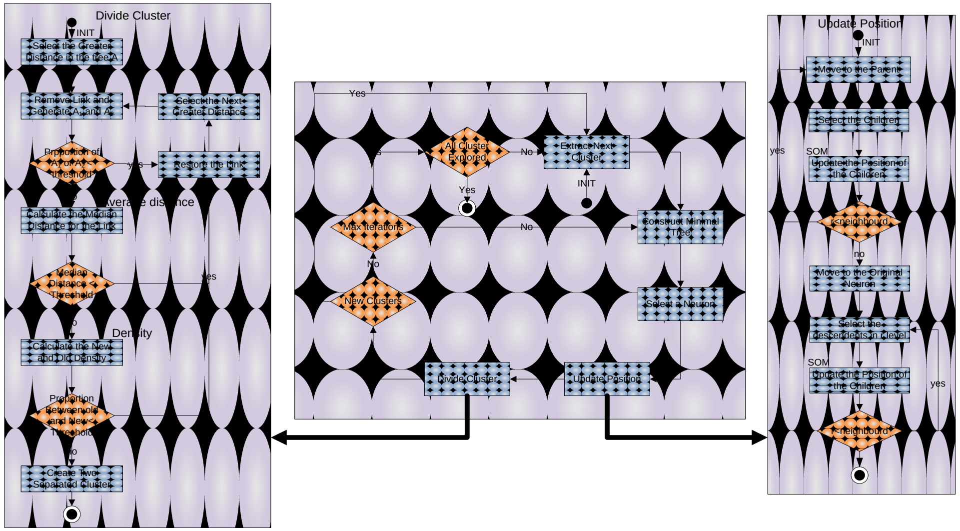
Clustering techniques

- Neural network based on mesh. Options
  - Self-organized Kohonen maps (SOM)
  - Neural Gas (NG)
  - Growing Cell Structure (GCS). The degree of proximity are set beforehand.
  - Enhanced self-organizing incremental neural network (ESOINN) doesn’t establish the degree of proximity
- It is necessary to adjust the neurons to the surface for the data that needs to be grouped

ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

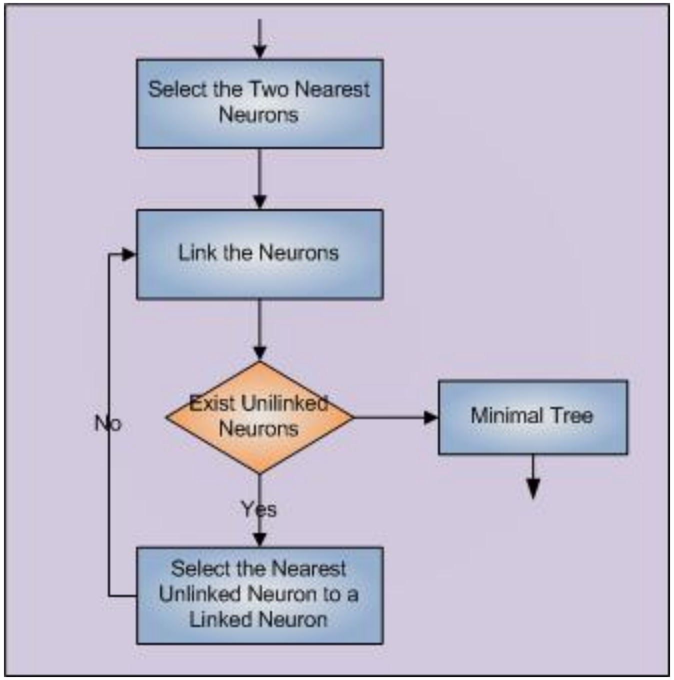
- Interconnection Algorithm
- Update Algorithm
  - Neighbour Function
  - SOM
- Division algorithm
  - Average distance
  - Density

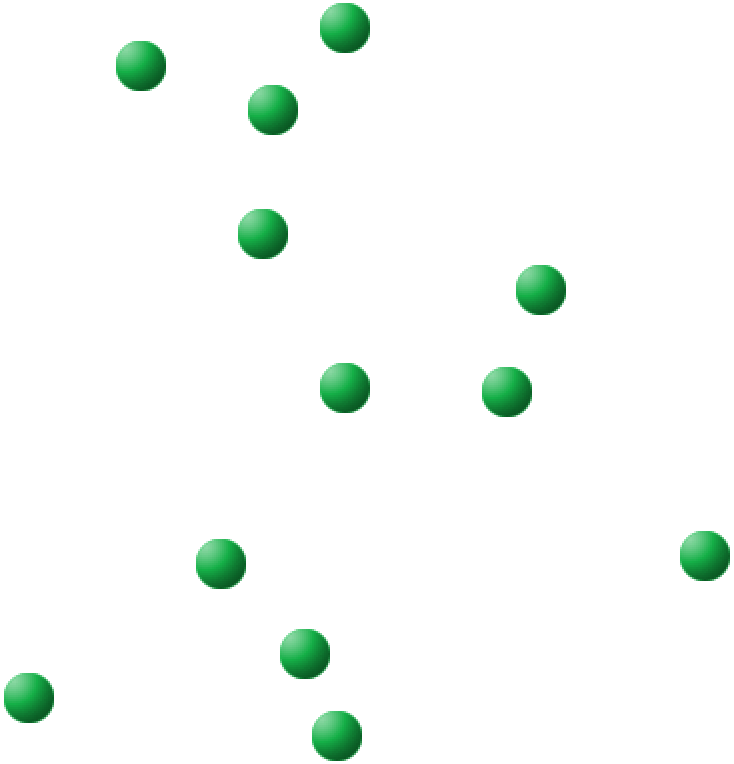
the ESODTNN does not distinguish between the original data and the neurons—during the initial training phase. It eliminates the expansion phase for a NG to adjust to the surface.



ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

- Interconnection Algorithm



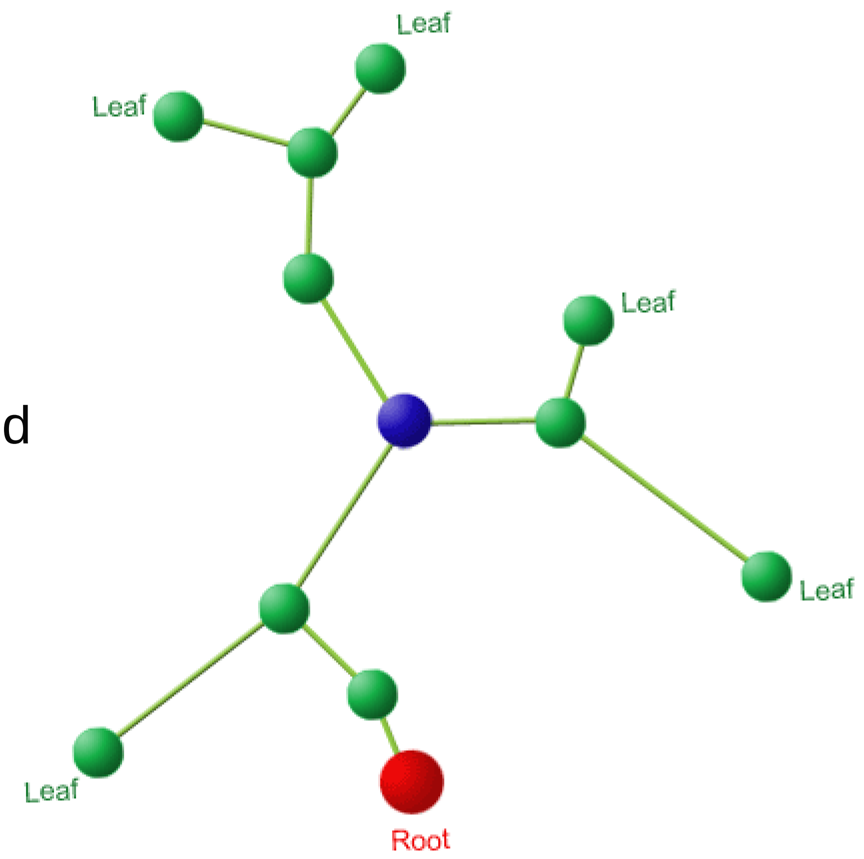


ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

- Density
  - Distance from tree $f^{A}(C,D)=\sum_{i,j} d_{ij} \text{ where } c_{ij}=1, c_{ij}\in C, d_{ij}\in D$
  - Distance between neurons in the tree $f^{T}(D)=\sum_{i,j} d_{ij}, d_{ij}\in D$
  - Calculate the final density $f^{D}(C,D)=f^{T}(D)/f^{A}(C,D)$
    - D is the distance matrix
    - C is the interconnection matrix

ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

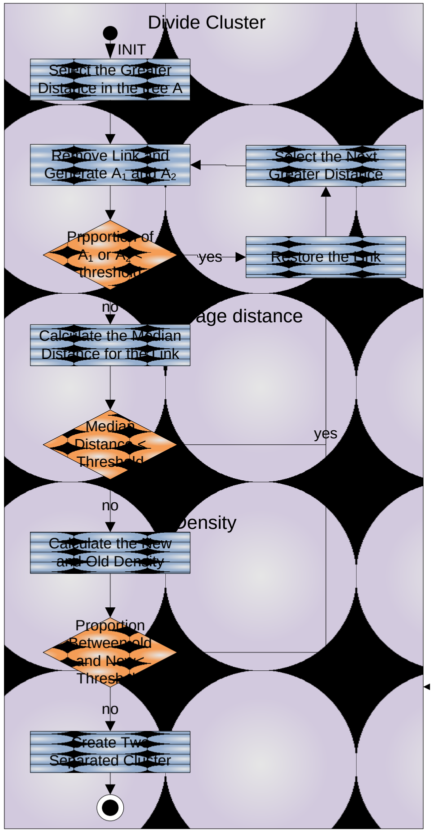
- Average distance
  - Select the origin neuron
  - Select the neuron that connects with the neuron in a certain range
  - The average distance is calculated based on the connections



ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

- Division algorithm
  - Select the greatest distance l
  - Remove the connection
  - If the proportion of elements for each subtree is greater than the threshold, continue
  - Calculate the average distance from the node for the tree
  - Determine if the distance from tree node and its parent is less than the average distance
  - Calculate the density of the previous tree and new trees
  - Re-establish the connection with its parent node if

$$\delta(t)/\delta(t+1) < 1/(\delta(0)/\delta(1)\cdot\rho)$$



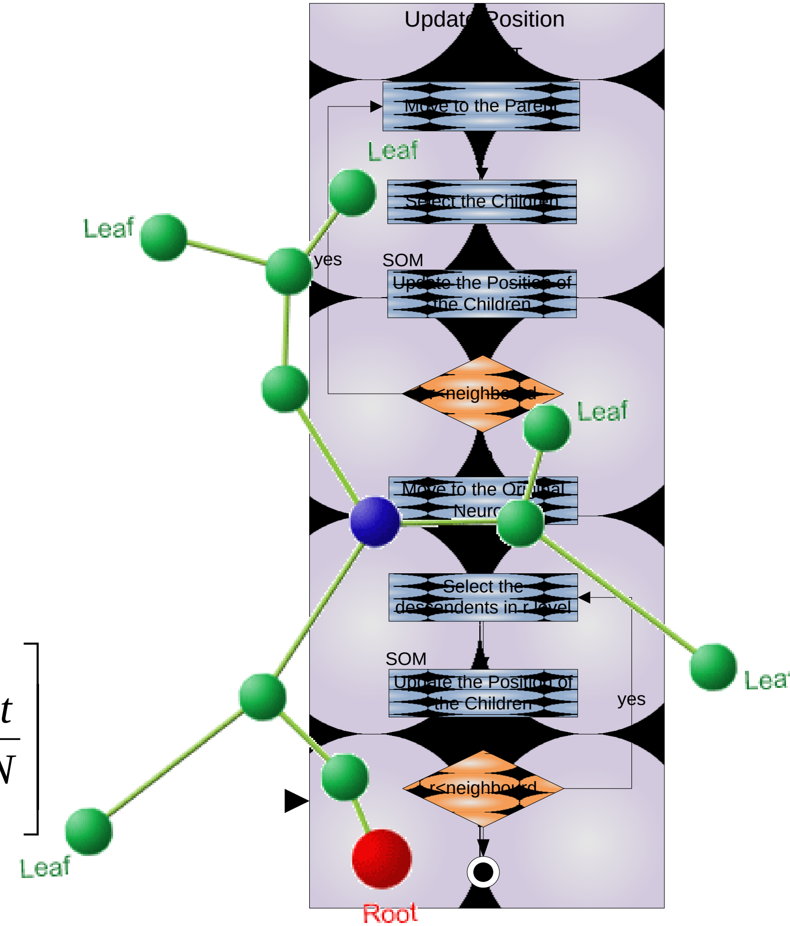
ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

- Update Algorithm
  - Select the subtree to modify
  - The neighbouring is associated with the hierarchical in the tree
  - The magnitude of the update depends on the hierarchical and the distance

$$x_j(t+1) = x_j(t) + \eta(t) \cdot g(i,t) \cdot (x_s(t) - x_j(t))$$

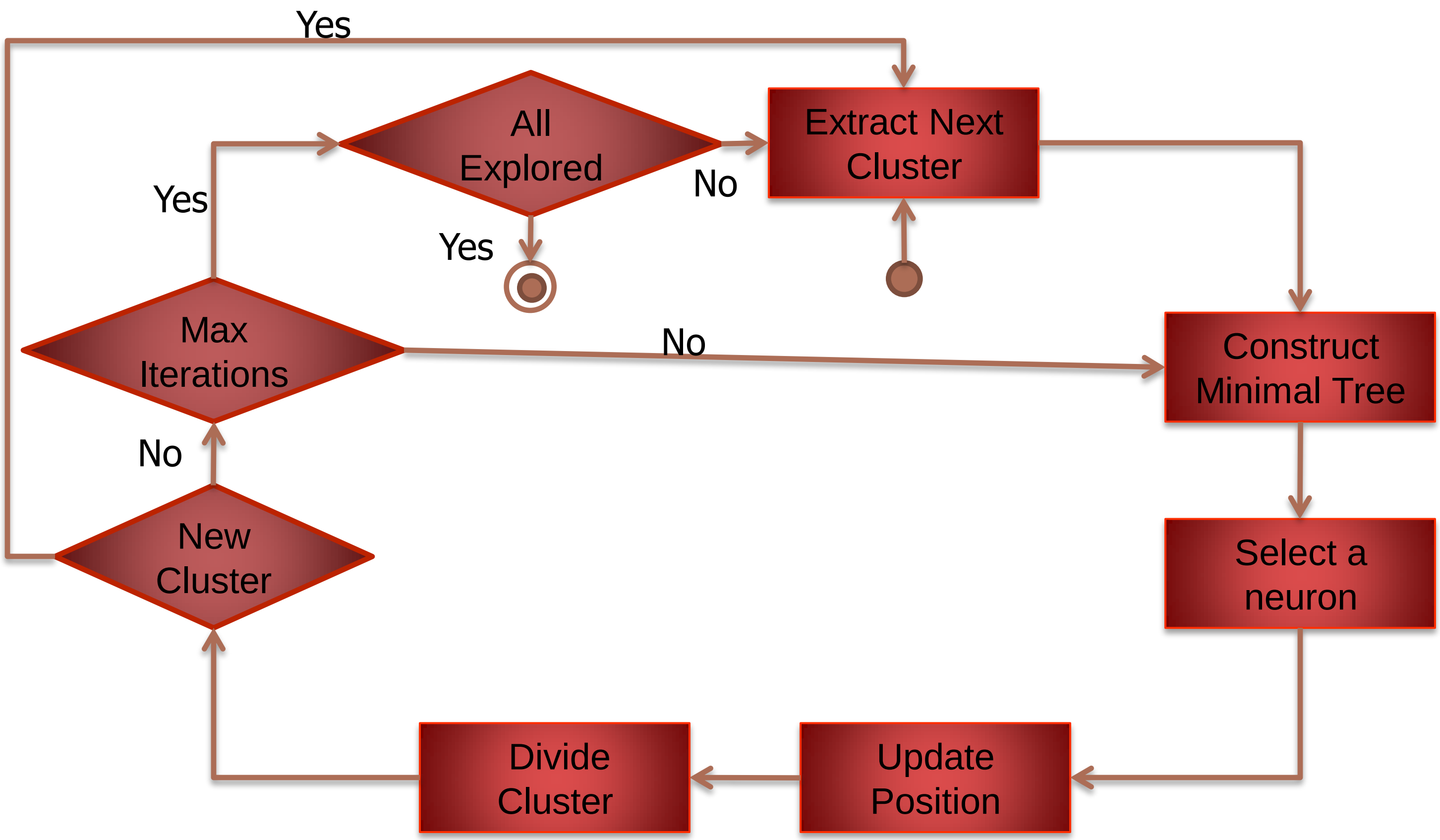
$$g(i,t) = Exp\left[-\frac{i}{N} \frac{\sqrt{(x_{j1} - x_{s1})^2 + \ldots + (x_{jn} - n_{sn})^2}}{\underset{i,j}{Max}\{d_{ij}\}} - \lambda \frac{i \cdot t}{\beta N} \right]$$

$$\eta(t) = Exp\left[-\sqrt[4]{\frac{t}{\beta N}} \right]$$



ESODTNN (Enhanced Self Organized Dynamic Tree Neural Network)

- Cluster Algorithm



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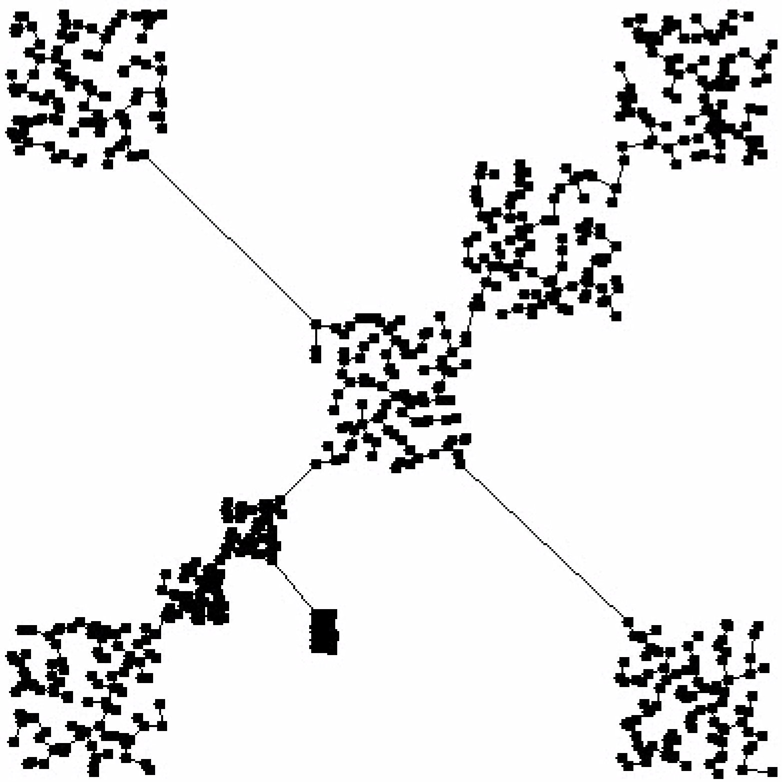

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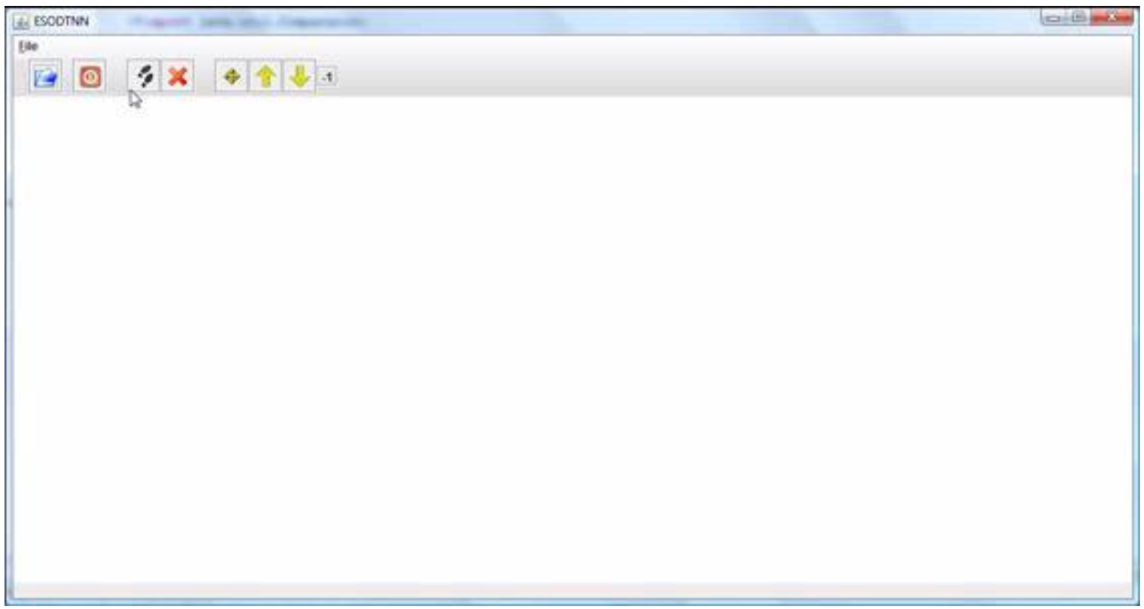
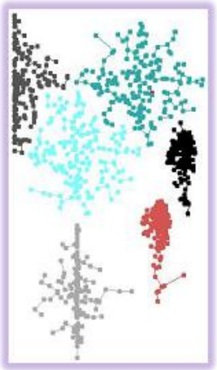
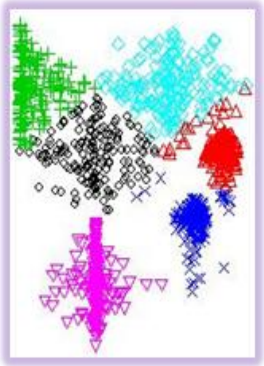


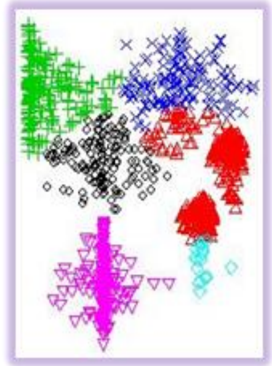
Results



ANN



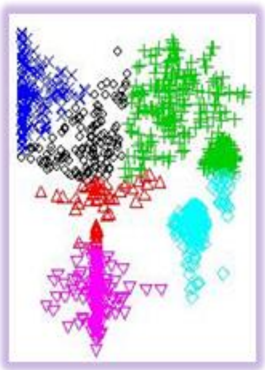
PAM



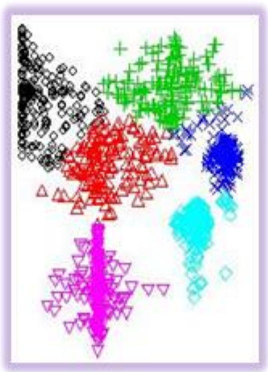
Dendrogram

FANNY

AGNES

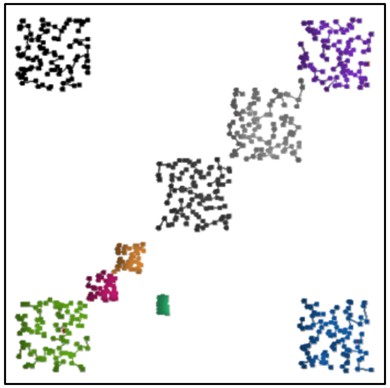


DIANNA

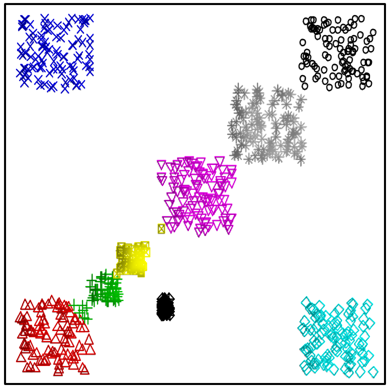


CLARA

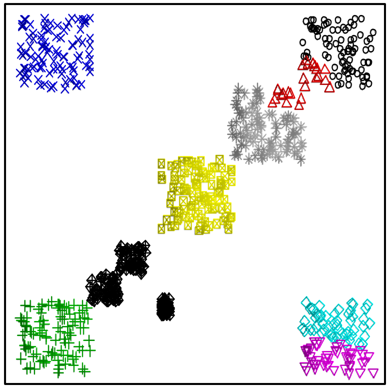
Results



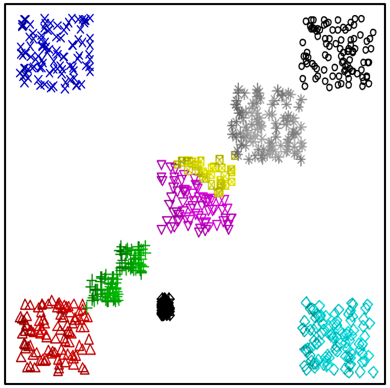
ANN



PAM



Dendrogram



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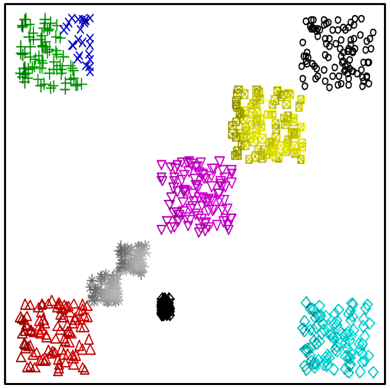
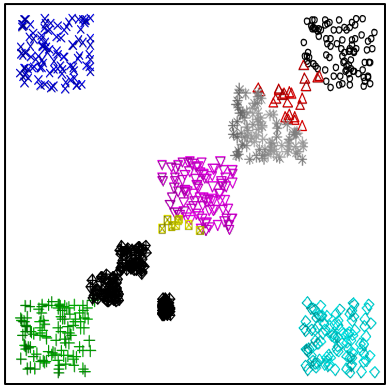


AGNES



DIANNA

Results

- UC Irvine Machine Learning Repository. Wine
  - ESODTNN: 91,01%
  - PAM: 90,45%
  - Dendrogram: 93,26%
  - Agnes: 33.71%
  - Diana: 71.35%

Conclusions

- The neural network is more adept at detecting the different forms.
- It eliminates the expansion phase
- We have detected several deficiencies in the case of elements that are distributed along very close parallel lines.
- Occasionally, the ESODTNN is incapable of calculating the correct cut-off point for dividing clusters and the results must be interpreted according to the distances from the cut-off points and the changes in density.

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