Adaptive Hyper-Fuzzy Partition Particle Swarm Optimization Clustering Algorithm

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Abstract
• An adaptive hyper-fuzzy partition particle swarm optimization (PSO) clustering algorithm is to optimally classify different geometrical data sets into correct groups.
• Use the novel hyper-fuzzy partition metric to improve previous used Euclidean norm metric clustering method.
• One fuzzy rule describes one pattern feature and implies the detection of one cluster center, it is encouraged to decrease the number of fuzzy rules with the hyper-fuzzy partition metric.

1. Introduction
Cluster analysis has been as an exploratory role in data mining, pattern recognition, system modeling, image processing, and other related fields. The most objective of clustering algorithm is to divide a given data set into several groups with similarity/dissimilarity metric. Hence, every individual group expresses maximum difference with each other and performs maximum similarity in the same group.

2. Hyper-Fuzzy Partition PSO Clustering Algorithm
• Suitable hyper-space fuzzy membership functions with an aggregation of hyper-ellipsoids are suggested to develop the robust hyper-fuzzy clustering metric, shown in Fig. 1. In Fig. 2, it shows the Euclidean type measure to estimate three different clustering data sets. Euclidean type metric is Not robust to tolerate noise and outliers. For one data point, it is too similar to determine the true group.

• Steps:
(a) randomly Initialize and its associated velocity for all particles (i.e. swarm). Here is the whole adjustable parameters set (R) with respect to p-th particle.
(b) Calculate the fitness function of each particle with

\[
\text{fitness} = \frac{1}{J_o + \sum_{i=1}^{k} \sum_{j=1}^{N} [1 - \text{HE}(x_i, z_j)]}
\]  

(1)

Where

\[
\beta = \left( \frac{\sum_{i=1}^{N} x_i - \bar{x}}{N} \right)
\]

(2)

It can be formulated as following searching problem:

\[
\text{MIN} \sum_{i=1}^{k} \sum_{j=1}^{N} [1 - \text{HE}(x_i, z_j)] \quad \text{MAX} \left( J_o + \sum_{i=1}^{k} \sum_{j=1}^{N} [1 - \text{HE}(x_i, z_j)] \right)
\]

(3)

(c) Applied the PSO learning algorithm to determine optimizations from the initializations.

3. Simulation Results
Two Examples with three different shapes, sizes and directions; two-cluster type data set in the shape of two unequal sizes with additional one outliers point, simulations are described in Fig 3-Fig 4.

4 Conclusion
Many traditional clustering methods, such as K-means and FCM, may have problems when they determine different sizes, irregular shapes or noise data set. In summary, an adaptive PSO learning algorithm with the hyper-fuzzy metric is proposed to solve the so-called traditional common used Euclidean norm metric clustering problems.