Fuzzy Systems
Prof. Dr. Rudolf Kruse, Christian Moewes

Assignment Sheet 13

Assignment 48 Programming

Generate fuzzy rules by fuzzy clustering the famous Iris data. Proceed as follows.

a) Download the Iris data set from the course web page.

b) Either implement the FCM algorithm as described in the lectore or find a suitable clustering software, *e.g.* `http://www.borgelt.net/cluster.html`.

c) Obtain the membership matrix U by fuzzy clustering the Iris data into three groups.

d) Project U down to the four attribute axis.

e) Compute the upper envelope of the membership degrees.

f) Compute the convex completion of them to diminish non-convex fuzzy sets.

g) Linearly interpolate the membership values to obtain membership functions.

h) First stretch and then normalize these functions.

i) Cylindrically extend these one-dimensional fuzzy sets to obtain the four-dimensional ones.

j) Plot your obtained fuzzy sets for each attribute.

Assignment 49 Validity of Fuzzy Clusters

Due to the minimization of an objective function, fuzzy clustering algorithms always find clusters even if the found groups are not suitable. Therefore validity measures have been introduced. Since these measures reduce the evaluation to only one number, information gets lost. Visualization methods offer an alternative to validity measures.

Develop visualization methods based on the following ideas. Hint: In general, the crisper the fuzzy partition, the better the clustering result.

a) How should a distribution of membership values look like regarding one cluster? What problem arises with an increasing number of clusters? How could this problem be solved?

b) Let $u_{i_1,j}$ and $u_{i_2,j}$ be the highest and the second highest membership degrees of a point $\mathbf{x}_j$. How should a scatter plot of $(u_{i_1,j}, u_{i_2,j})$ look like for all x_j? Are there any constraints that restrict the location of points in this plot? If yes, which ones?

c) Let d_{ij} be the distance between data point $\mathbf{x}_j$ and cluster centroid $\mathbf{c}_i$. Consider c scatter plots (one for each cluster) of the points (d_{ij}, u_{ij}) for all data points $\mathbf{x}_j$. How should a desired graph look like?

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Assignment 50 Programming

Implement all three visualization methods of fuzzy membership matrices mentioned in Assignment 49 to validate fuzzy clustering results. Test these methods using the Iris data set from the web page. In particular, show the corresponding effects using different values for c, *e.g.* 2, 3 and 4.