A Relative Entropy Regularization Approach for Fuzzy C-Means Clustering Problem

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Abstract : Clustering is an unsupervised machine learning technique; its aim is to extract the data structures, in which similar data objects are grouped in the same cluster, whereas dissimilar objects are grouped in different clusters. Clustering methods are widely utilized in different fields, such as: image processing, computer vision , and pattern recognition, etc. Fuzzy c-means clustering (fcm) is one of the most well known fuzzy clustering methods. It is based on solving an optimization problem, in which a minimization of a given cost function has been studied. This minimization aims to decrease the dissimilarity inside clusters, where the dissimilarity here is measured by the distances between data objects and cluster centers. The degree of belonging of a data point in a cluster is measured by a membership function which is included in the interval [0, 1]. In fcm clustering, the membership degree is constrained with the condition that the sum of a data object's memberships in all clusters must be equal to one. This constraint can cause several problems, specially when our data objects are included in a noisy space. Regularization approach took a part in fuzzy c-means clustering technique. This process introduces an additional information in order to solve an ill-posed optimization problem. In this study, we focus on regularization by relative entropy approach, where in our optimization problem we aim to minimize the dissimilarity inside clusters. Finding an appropriate membership degree to each data object is our objective, because an appropriate membership degree leads to an accurate clustering result. Our clustering results in synthetic data sets, gaussian based data sets, and real world data sets show that our proposed model achieves a good accuracy.

Keywords : clustering, fuzzy c-means, regularization, relative entropy
Conference Title : ICFLSEA 2018 : International Conference on Fuzzy Logic Systems for Engineering Applications
Conference Location : Paris, France
Conference Dates : October 29-30, 2018