

Fuzzy clustering algorithms based on the maximum likelihood principle

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Abstract: A number of hard clustering algorithms have been shown to be derivable from the maximum likelihood principle. The only corresponding fuzzy algorithms are the well known fuzzy k -means or fuzzy ISODATA of Dunn and its generalizations by Bezdek and by Gustafson and Kessel. The authors show how to generate two other fuzzy algorithms which are the analogues of known hard algorithms: the minimization of the fuzzy determinant and of the product of fuzzy determinants.

By comparison between the hard and fuzzy methods it appears that the latter yield more often the global optimum, rather than merely a local optimum. This result and the comparison between the different algorithms, together with their specific domains of application, are illustrated by a few numerical examples.

Keywords: Fuzziness; cluster analysis; algorithm; maximum likelihood.

1. Introduction

In situations where a large amount of data has to be analysed, it is useful to look for clusters first. Many clustering methods are based on the search for centroids or representative objects around which all observations will be clustered on a minimum distance basis. However, this approach tends to identify only hyper-spherical clusters with equal diameters.

To search for clusters of different shapes, Scott and Symons [12] proposed a variety of methods based on the maximum likelihood principle, leading to the minimization of the product of the determinants of the scatter matrices. The minimum variance criterion of Ball and Hall [1] is a particular case of this approach. Moreover, the link between this last method and fuzzy k -means was established by Dunn [6].

This paper proposes a generalization of some of the hard maximum likelihood clustering methods to the fuzzy approach, leading to some new fuzzy clustering algorithms. In particular, a fuzzy version of the minimum determinant [7] and of the minimum product of determinants [12] is derived. Finally, some properties and features of the different methods are discussed and compared with each other.

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