

Chapter 3

Set Classification

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ABSTRACT

The classification problem where each object is given by a set of multidimensional measurements that is associated with an unknown dependence is considered. Intersection of sets that define objects from different classes is allowed. In this case, it is natural to find classification algorithms based on the difference between dependencies for the objects belonging to different classes. Two algorithms to convert the set classification problem solution from the initial feature space into (1) the parameters space of the common model structure for all the objects and (2) the parameters spaces of the best structures for each class are proposed, along with a classification algorithm based on the accuracy of object representation by the models based on the structures found for each class. If the objects are described with big data, the approach can be used to transform data into a compact form (model parameters) that preserves the characteristics that are necessary to separate the classes. An approach to solve a problem of clustering sets is proposed. Some examples are given.

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INTRODUCTION AND HISTORY OF SOLUTIONS

An important role in the functionality of techno-social systems in Modern Economical and Governmental Infrastructures plays by decision support making systems. The mathematics of such decision-making is most often classification methods. The system operation conditions in these areas are characterized by a high degree of task subjects' behavior ambiguity and the presence of hidden variables, knowledge of which is essential for making management decisions. It is for such decision-making tasks the approach proposed by the authors is intended.

Historically, pattern recognition problem considers a classification object as a single multidimensional point (observation) in a feature space, this condition will hereinafter be denoted for reference in this text as (*). At the same time, if the “portraits” of objects are insufficiently informative, the well-known issue of ambiguity solution of classification problem arises. Difficulties in recognizing become even more obvious if the object feature values can vary depending on the magnitude of some uncontrolled parameter or, in general, on the environment state. The problem stems from the possibility of feature value areas partial intersections in the original space of measured variables for objects of different classes in the various environment states, that leads to the obvious ambiguity of the classification result.

A possible way out is to describe the object not by one, but a certain number of measurements taken for the different environmental states. Such a set of measurements makes it possible to presence the classification object more accurately as a certain set of its states in the original multidimensional space. As a consequence, we turn to a new class of classification problems where objects are defined by sets of multidimensional measurements, we denote the specified condition for a reference in this text as (**).

However, the solution of problems class (**) meets certain difficulties because of an overwhelming majority developed approaches to solve the recognition problem assume a single measurement of the object features, in addition, the areas partial intersections of the original feature space for classification objects from different classes are allowed. These conditions do not allow one to direct use the individual observations for object classification, but require the development of special approaches where it is possible to operate with measurement sets or with characteristics derived from these sets or with parameters of various expedient expansions of obtained characteristics in model range. Thus, approaches to solve the problem under condition (**) are divided in two groups: direct solution of problem (**) and approaches that consider reducing the problem in wording (**) to the problem in formulation (*).

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