

SECTION XIX. GÉNIE INFORMATIQUE ET LOGICIEL

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COMPOSED APPROACH TO IMAGE OBJECT RECOGNITION

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The reason for the rapid development of pattern recognition information technologies is the need for high-quality automation of the real-time processes in manufacture [1-4], robotics (grasping, manipulation, human-robot interaction etc.) [5], medicine [6-8] etc. Therefore, the development and the implementation of approaches to the transfer of human cognitive functions by computerized systems is the actual task.

The pattern is an ordered set of features. The class of patterns is a set of patterns which have general characteristics. The recognition is the process of applying the mathematical methods that allow to automate relate a pattern to certain class.

The objects of recognition can be described by quantitative, qualitative and structural features. Characteristics of quantitative features are numbers, characteristics of qualitative and structural features are symbols. For example, the area of the recognition object is the quantitative feature, its shape is the structural feature, the presence of occlusions is the qualitative feature. These features describe a recognition object differently and can form a single feature space.

The feature set forms a space which should be complete, and the features themselves should be informative. The feature informativeness depends on the approach to describing the object recognition. The color and the brightness can be uninformative features for recognizing two classes, for example, cars and trucks, but the area and contours are the opposite.

The example illustrated the importance of the stage of determining the feature space is shown in fig. 1.

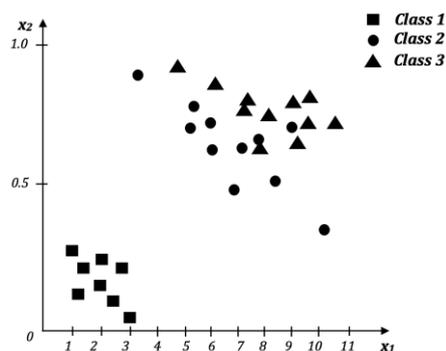


Fig. 1. Example №1 of three classes of patterns described by two quantitative features

A pattern is described by the results of computing two features, which leads to a two-dimensional feature vector (1)

$$x = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}. \quad (1)$$

The patterns are characterized by the variability in the values of feature vectors within one class, as well as several classes. *Class 1* is the sufficiently separated from others classes by data of two features in fig. 1. However, it is impossible to separate *Class 2* and *Class 3* within the defined feature space. It can be assumed that the feature space (fig. 1) defined by x_1 та x_2 features is not complete enough to separate all groups of the patterns and needs to be expanded with additional informative features.

The example of the uninformative features is shown in fig. 2, when the separation of the pattern groups is impossible.

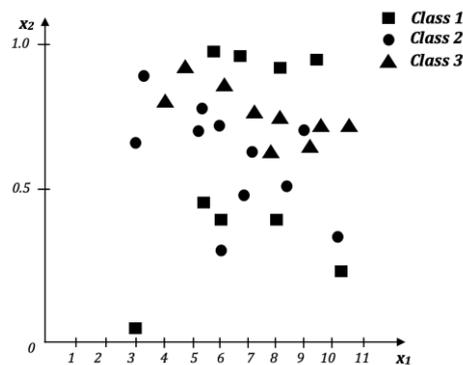


Fig. 2. Example №2 of three classes of patterns described by two quantitative features

These examples (in fig. 1 and in fig. 2) illustrate the classic problem of feature selection based on the fact that the degree of the division of classes directly depends on initial data and determined features to them.

The pattern recognition methods can be divided on the following categories: the methods based on quantitative features (in fig. 1 and in fig. 2) and the structural methods (in fig. 3). In a number of practical problems, for example, fingerprint recognition the pattern characteristics can be better described by structural methods. That is, the affiliation to class is defined by the spatial relationship between features, but not the quantitative measurements.

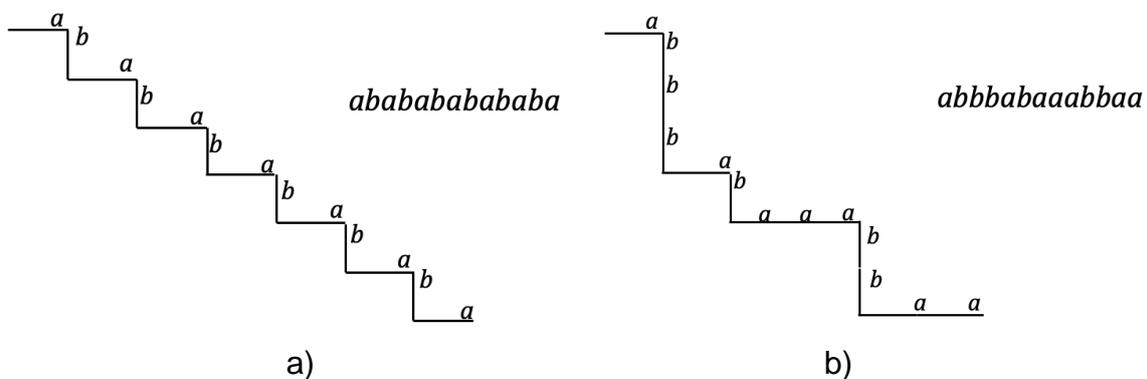


Fig. 3. Stepped structure: a) structure encoded by *a* and *b* elements in the form of *ababababababa* character string; b) structure encoded in the form of *abbbabaaabbaa* character string

In fig. 3 shows the structures formed by the repetition of two elements: the horizontal and the vertical line. The structural recognition methods are based on determining the primitives (a is the horizontal line, b is the vertical line), forming the pattern ($ababababababa$ and $abbbabaaabbaa$ character strings) and determining the degree of similarity of the obtained patterns. The similarity of character strings can be a process of converting structural data into quantitative data by computing (2)

$$S = \frac{1}{N} \times$$

$$\sum_{i=1}^N d_i, \quad (2)$$

where $d_i = 0$, if the elements don't match, $i = 1, 2, \dots, N$,

$d_i = 1$, if the elements match,

N – the number of elements in the string,

$S \in [0; 1]$.

In the case when it is necessary to give some elements of the string "importance" relative to others, to simplify further computing $d_i > 1$, in case if the elements match.

The description in the form of character strings and determination of similarity is an effective method of recognition for such objects, the structure of which is based on a combination of simple primitives (boundaries, contours of the recognition object), capable of informatively and fully describing the recognition object. For many practical problems, a more effective method of recognition will be a composite approach based on forming the feature space from quantitative and structural data.

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