

A Detailed Anatomy of Pattern Recognition

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ABSTRACT

Pattern Recognition is evolving at a growing footstep in the field of Artificial Intelligence. Pattern recognition deals with the task of arranging some entity to a correct class based on the features of the object. It is the branch of science that deals with the making of machines or devices as intelligent as human to identify patterns and differentiate them into appropriate categories in a simple and flexible way. It recognizes hidden information in data. This review paper introduces the basic concepts of pattern recognition, the underlying system architecture and provides the understanding of various representations for categorizing and clustering and the application of pattern recognition.

Keywords: Pattern, Recognition, Pattern Recognition, Supervised Learning, Unsupervised Learning, Feature Extraction.

I. INTRODUCTION

The task of recognizing patterns and differentiating patterns accordingly has been achieving popularity from a long time and persons have developed highly experienced skills for sensing from their scenario and take actions according to what they notice.

So, a human can identify the faces without bothering about the varying glitter, facial rotation, facial expressions, and facial biometrical changes and also clotted face images. It's a very complex task when it comes to actually implement such recognition artificially. The traits of artificial intelligence have made this complex job possible by making machines as brilliant as human to identify patterns in altering environmental conditions. Such a branch of artificial intelligence that deals with patterns is known as pattern recognition.

Pattern Recognition provides the alternatives to a lot of dilemmas that fall under the division of either recognition or categorizing, such as speech recognition, face recognition, categorization of handwritten characters, medical diagnosis etc.



Figure 1. Different Type of Patterns

Pattern Recognition = Pattern + Recognition

Pattern

Pattern can be considered as set of entities or objects where the components are similar to each other in various ways. More precise, description of object or entity can be also defined as pattern.

Pattern can be described by its quantity, quality, attributes, custom features, and distinctness and so on.... Pattern could be anything a finger print image, handwritten signature, any human face, signal carrying speech, a bar code, or any captcha code in web page on internet, finger print lock or finger print scanner.



Figure 2. Examples of patterns: three sky pattern of the similar season.



Figure 3. Examples of patterns: three sky pattern of the distinct season.

Generally, a pattern is defined by the common statistics among the multiple instances of an entity. See Figure 2 - showing different sky patterns of the similar season such as monsoon season and in Figure 3 - showing different sky patterns of the distinct seasons.

Recognition

Cognition: - To become familiar with, to come to know the move, or the process of knowing an object.

Recognition: - The information or understanding that the present object has been met before or else you can say recognition is grouping an object to a pattern class.

Pattern Recognition

Pattern recognition is the branch of science that deals with discovering or sensing the scenario, learning to classify patterns of interest (e.g., creatures) from their background (e.g., airspace, trees, and ground).

Pattern recognition is a field within the area of machine learning with the objective to categorize patterns based either on pre-existing knowledge or on statistical information extracted from the patterns. It is the science that deals with recognition of measurements.

II. BASIC COMPONENT'S OF PATTERN RECOGNITION(Classification)

Pattern recognition comprises of the separation of patterns from data, their analysis and, ultimately, the recognition of the class each of which pattern belongs to. To categorize objects into appropriate and suitable class based on the measurements and attributes of the object is a main objective of pattern recognition.

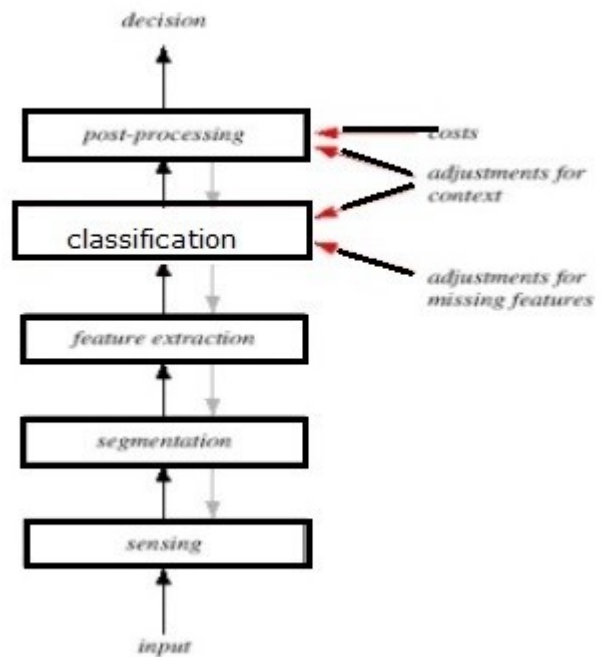


Figure: 4 Classification of objects

CLASSIFICATION OF OBJECTS

Acquiring Model Inputs

In Acquiring inputs, a device known as transducer comes in the scenario. A transducer is a device that converts one form of energy to another. Physical signals are converted to digital signal with the help of transducer. Later the area of interest is recognized, attributes are computed for this region. Input can be camera or microphone array.

Sensing

The observation of the object is done and measurements are taken. Here the transducers are used. Pattern recognition system depends on the bandwidth and resolution sensitivity, and transducer distortion.

Pre – Processing & Segmentation

Pre-processing refers to refining the raw data to reduce data complexity and for suppression of noise or any variation, and applied before feature extraction to allow and simplify feature computations in order to improve its quality.

Classification of the entire data in to individual objects is done.

In segmentation, the measurement data is splitted so that each section represents exactly one entity to be categorized.

Feature extraction

Feature Extraction refers to calculating features for inputs dynamically. A group of attributes measurements (numerical or non-numerical), and their relations are extracted to constitute patterns for processing later.

Feature Selection

Selecting from available features, those to be utilized in our categorizing model. Ideally, distinguish well between classes and those are simple and efficient to compute.

Types of Features

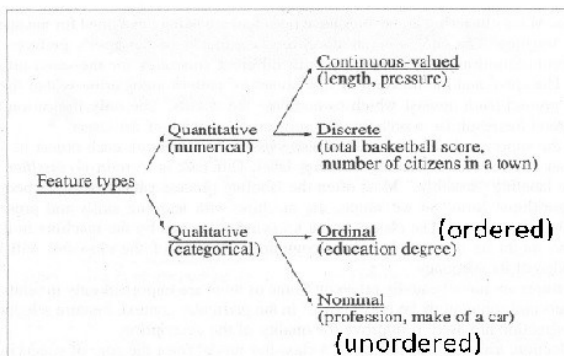


Figure 5. Types of features

Classification

The process or events with homogenous attributes are grouped into a category. The number of category is task-dependent.

Post-processing

Post –processing refers to as a considering the impacts of context and the amount of errors.

III. LEARNING TECHNIQUES

In supervise learning, to train the machine, output datasets are provided and get the desired output whereas in unsupervised learning data is bundled into different classes and no datasets are available.



Figure 6. Baskets of Fruits that is to be classified

Supervised and Unsupervised Learning

Supervised Learning

Assume that you have the container which is loaded with some fresh fruits and your job is to shuffle the same types of fruits at same place. Assume that the fruits are raspberry, apple, banana, and grapes. From the experience of your previous work, the shape of each and every fruit is known by you and so it's easy to arrange the same type of fruits at one place. In data mining the train data is called previous work.

No.	SIZE	COLOR	SHAPE	FRUIT NAME
1	Big	Red	Rounded shape with depression at the top	Apple
2	Small	Red	Heart-shaped to nearly globular	Cherry
3	Big	Green	Long curving cylinder	Banana
4	Small	Green	Round to oval, Bunch shape Cylindrical	Grape

Table 1. Supervised Learning

You have already learned from your train data, because you have the response variable which indicates that particular fruit have so and so characteristics, and that likewise for all the fruits. You know all this from the train data and this type of learning is called supervised learning and solving problem is called classification.

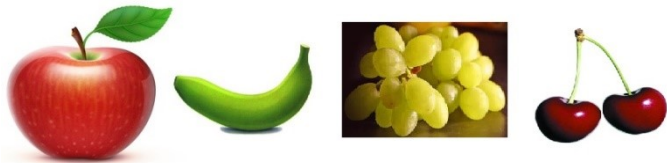


Figure 7. Classification of fruits

Unsupervised Learning

Assume that you have the container which is loaded with some fresh fruits and your job is to shuffle the same types of fruits at same place. Assume that the fruits are raspberry, apple, banana, and grapes. This time you don't have any knowledge about the fruits and you are seeing this fruits for the first time, so how can arrange the same.

What you can do is select any physical character of particular fruit, say for example color and arrange them base on the color, then set can be formed like red color group which contains apples and raspberry and green color group which contains bananas and grapes.

Now you categorize them into another physical character such as size, so set can be formed something like this red color with big size implies apples, red color with small size implies raspberry, green color with big size implies bananas, green color with small size implies grapes. And finally, your job is done! Very simple and you don't have any trained data and no response variable.

IV. EXPLANATION WITH REAL LIFE EXAMPLE

We will consider the example of student. Consider the student as the object. Student object can encapsulate attributes and methods both.

First and foremost, we need to identify gender of the student.

- (1) The student to be classified is an entity or object.
- (2) The gender (Male or Female) are the classes.

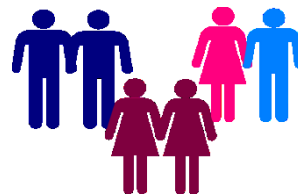


Figure 7. Example showing classification of gender

Later encapsulate two things that are attributes and methods.

- (1) Attributes: - characteristics or features of the objects.
- (2) Methods: - Mechanisms to define what is exactly pattern.

Attributes

Attribute can be defined as feature or quality of entity which is used to identify them. Attribute can be numeric, non-numeric, or symbolic. Some of the possible attributes of the student are listed in the table.

Attribute	Range/Limit
Name	[a-z, A-Z]
Enroll_no	[0-9]
Marks	[0-9]
Hair color	{0 =Black, 1=white, 2=brown ...}
Wear Glasses or not	{0,1}
Complexion	{0=white,1=fair,..}
Height[cm]	[40....200]
Weight[kg]	[30...150]

Pattern

It is an n-tuple X (vector) of N scalars $x_i \ i \in [1,N]$, which are called the attributes. Conventional form of a pattern is:

$$X = [x_1 \ x_2 \ \dots \ x_N]^T, \quad x_i \in \square, \ X \in V$$

Where V is known as the Feature Space, and N is the dimension of V .

Possible patterns for the student problem:

We can use Enroll_no alone to have:

$$X=[\text{Enroll_no}]$$

We can combine the height and the weight to have:

$$X=[\text{height,weight}]$$

Class

Class is a way of encapsulating attributes and methods. Class is a collection of patterns that share some common attributes. In our example, gender, can be categorized in to male student or female student.

V. APPLICATIONS OF PATTERN RECOGNITION

Pattern recognition deals with the area of science and engineering that focuses mainly on constitution of surveys. Pattern Recognition can be used in many applications such as Medical field, industries, organizations, military services, document scanners, mobiles, securities.

Document scanning:-In document scanning optical character recognition is an essential component, and it is utilized in postal and banking areas. Characters that are printed are accurately recognized and the improving performance of automatic recognition of handwritten cursive characters has decreased particularly the need of human interaction for OCR tasks.

Automatic speech recognition: - it is very essential for human interaction with machines. Enterprise systems for automated response to flight enquires, telephone directory assistance and telebanking are obtainable. For desirable recognition accuracy, systems are tuned to a specific speaker.

Computer vision deals with identifying of entities as well as the identification and localization of their three-dimensional environments. This proficiency is required, for example, by robots to drive in dynamic or unknown scenario. This can be applicable from applications classification from manufacturing to household cleaning, and even for rescue missions.

Individual's identification: - From security point of view in places or applications such as ATM's, shops, restaurants, airports, hotels, systems that need secure computer access uses biometrics which are mandatory in individual's identifying system.

Character recognition: - Automatic mail sorting is done, it can process blank checks, scanner captures a picture of the text; image is translated into constituent characters.

Speech recognition: - Individual system interaction, Universal access, Micro-phone records acoustic signal, Speech signal is distinguished into phonemes and words.

VI. REFERENCES

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