**PATTERN RECOGNITION**

**College of Computing Sciences & IT**

**Teerthanker Mahaveer University, Moradabad**

**Submitted by:-**

Aniket Sinha (TCA1959047)

Charu Saxena (TCA1959050)

# ABSTRACT :-

The paper discusses about the different role of Pattern recognition in a paving way. It further talks about brief history of pattern recognition, by covering the all present problems and process to be done in pattern recognition and ended this paper with important different method or algorithm present in today's scenario. The literature presents an overview about every aspect of Pattern recognition.

# INTRODUCTION:-

Pattern recognition is the combination of artificial intelligence and machine learning. Pattern recognition is the human ability to see and observe a pattern. In the digital world, everything has its own pattern. Everything in the real world is a pattern and it can be identified by its pattern or structure. A pattern is either seen physically or it can be observed by some mathematical observation.

In the present world the scientists are taking the initiative to make a machine which acts like a human and have an ability to recognize and observe the pattern like a human, this can be done by machine learning algorithm, it is a classification of knowledge that is already gained by a machine it will extract the pattern and observer whether it is matched or not.

But what is pattern recognition in machine learning? In machine learning, pattern recognition is the technology that matches the information stored in the database with the available data. Pattern recognition is used in various aspects like speech recognition, speaker identification, multiple document recognition, medical diagnosis, etc.

The Motive of pattern recognition is based on the situation that the decision-making process of a human being is somehow related to the recognition of patterns. For example, the upcoming move in a chess game is totally based on the board’s current pattern and buying or selling stocks is decided by a complex pattern of financial information.

Pattern recognition must have these following features in it:

* Pattern recognition must recognize familiar patterns with high-speed accuracy.
* Pattern recognition must recognize and differentiate the unfamiliar objects.
* Pattern recognition must recognize shapes and objects from various angles.

Applications of pattern recognition:

* Image processing: - Pattern recognition is used to provide human recognition intelligence to machines which are required in image processing.
* Computer vision: - Pattern recognition is used to extract useful features from a given document samples and is used in computer vision for various applications.
* Radar signal analysis: - Pattern recognition and signal processing techniques are used in various applications of radar signal analysis.
* Speech recognition: - Pattern recognition bought drastic success in speech recognition. It is getting used in different algorithms of speech recognition.
* Fingerprint recognition: - Fingerprint recognition technology is a new technology in the biometric area. Various numbers of recognition methods are used to make this system more optimal and accurate with the help of pattern recognition algorithms.

# Evolution of Pattern Recognition

For any pattern recognition system, performance is its top priority. To evaluate performance of any pattern we need false acceptance rate and the false rejection rate to judge it. In early days of pattern recognition, the false acceptance rate and rejection rate was so high but as evolution takes place with time and efficiency the rate of false acceptance and false rejection decreases.

In early days there was very difference in identification and verification, due to this people uses different algorithms to measure the efficiency. Now-a-days every pattern recognition takes five phases to optimize and finalize the solution it very begins with sensing which detects the pattern after that it moves to segmentation where all data broken down into various sub groups then feature segmentation comes into process later on we do classification of data with the help of different classification algorithms, then we move to post processing and after post processing we make our decision on behalf of our given input.

## BACKGROUND: -

The pattern we are recognizing is questionable that it arises from where in the world? Are they part of the outside world or the observer has originated it from his concepts? did he get in his mind? It is claimed they are invented during observation, based on the knowledge of observation ability. For a skilled observer, he would directly recognize that object or event without performing any reasoning. Subsequently, he may be able to reveal what reasoning or features he might have used for his recognition. Further, the discussion is expressed in the rational debate between monism and dualism. In monism, the observer is the part of the observed world whereas in dualism these two are fully separated. From a monastic point of view, we can understand direct recognition. Dualism may arise after defining features and formulating reasoning. An artificial pattern recognition system creates a clear dualistic situation that is based on these specifications. It uses physical sensors and mechanical reasoning to separate the two worlds. With the supervised integration of artificially intelligent systems, we can solve this dualistic situation.

Descartes (Russell,1946) has defined that modern science is based on spinning the two worlds: the res Extensa, that is we can perceive the external world by our senses, and the res cogitans, which states our thoughts, actions, and our being are grounded by our internal consciousness. We perceive the world and learns the law of nature, the weather, the consistency of events in the sky vault, the tides, the manners of human, their lifestyles, languages, etc. Next, we utilize this knowledge to sustain on Earth, interconnect with our peoples, and grow consistently. Thus, we achieve life stability and stance. The field of automatic pattern recognition studies this process directly by simulation and by scheming tools to proceed with them. For these processes to happen various closely related regulations are therefore needed, like machine learning, artificial intelligence, sensor technology, robotics and mathematics, and video and audio processing.

Amazingly, we can identify or recognize an object as a table even if we have never seen this specific object earlier, even if it has been designed completely different from all the tables we have seen before. This capability is very known, but at the same time, it may also seem to be a wonder. The sandalwood can be identified from its leaves. The characteristics of fathers in the activities of his son, the writer by the content he is written. Here we are making observations on leaves, activities, furniture stuff, and ways of writing consciously. Even so often these kinds of observations are unconsciously organized into classes or groups in our minds. When we confront the new object of a class, we identify it and are now able to do its classification which is to assign its class name. We termed this potentiality as a generalization. We are having a group of observed objects and the name of the class is not necessary to be the same for this group of observed objects. It mentions something profound. There is a possibility that it may refer to the infinite set of known or unknown objects. The frontier of this sets not well explained.

In the pattern recognition system, we are aiming to fill the gap between the worlds of objects and the world of concepts. As we have explained above, we do this naturally, but it is not less than a miracle initially. Several features are studied in biology and physiology, starting from the human mind to the human body. The first columns of the metaphoric bridge are erected at the other bank, the world of objects in automatic pattern recognition. It analyzes real-world objects and events and they are explained by their structures and features, e.g., by computer vision. This process is carried out by using the tools of machine learning to search for a pattern or an assignment to the predefined class.

The accurate locations of the bridge, the group of objects where it begins, and especially the concepts where it lands, are controlled by what is already present in the mind. This is referred to as prior knowledge as it is already known to us before we perform the observation. Artificial recognition systems operate completely in the external world. They are directed with sensors and produce results on patterns and classes which are based on computer algorithms. The algorithm is formulated by man along with sensors and the output is given to someone interested in them. e.g., a security agent or a doctor.

# Problems in Pattern Recognition: -

There are mainly two problems that occur in pattern recognition i.e., the first is feature extraction and the second is the training dataset. In real life, data varies considerably. There is no guarantee that a feature is present in the data or not. Pattern recognition is simply following the classification and cluster of patterns. Classification is a supervised machine learning algorithm in which the class label is assigned to the pattern based on the abstraction of a set of training data or domain knowledge. Clustering is an unsupervised learning technique in which we make clusters of similar data patterns and assigned the class label. In Pattern recognition, the raw data is proceeding and converted into machine-readable language. If pattern recognition is a problem, then machine learning is the solution to identify the pattern.

Feature extraction is the process that converts raw data into a numerical feature that can be processed while preserving the information in the data. There is no guarantee that you will choose the best training dataset for training the model there is no such guarantee you will always get the dataset of the related problem as we know that the machine learning model needs a huge number of datasets to train the model and based in this it will give output. The training dataset also missing values, noise, data redundancy, data inconsistency, etc. which is not good for accuracy.

For unsupervised if we give the pattern the model is not sufficient to make a cluster as there is no prior knowledge and training dataset belonging to it, but for supervised if we give a pattern then the model will classify from the prior knowledge and based on this it will recognize the pattern because in supervised the input is labeled with output. The most important challenge that which technique is used to recognize the pattern or which technique is suitable for the problem.

The challenges that mainly occur during pattern recognition: -

* Data Collection
* Segmentation
* Feature Extraction
* Classification

**Data Collection:** Whatever the form of input data it will sample at fixed intervals in time or image metrics. Any noise will be disadvantageous as it will affect the accuracy of the model and will affect the output. So, to clean the noise from the data we have a lot of techniques to remove the noise from the data such as filtering and replacing the missing value with the attribute mean median, and boundary value. And fill the missing value with “NA” or “None” or “Not Available”.

**Segmentation:** The segmentation will add the information regarding the segment boundaries to the data flow or copy all the segmentation in a separate buffer and hand it over to other stages one by one.

**Feature Extraction:** We don’t have completed for all kinds of objects. It is still a big question whether the feature that you extract is not strongly present in the data. It converts the raw data into numerical feature and while processed it preserves the information in the original set.

**Classification:** It is a very crucial step of pattern recognition as the primary division of the various classification algorithms used is between syntactic and statistical methods. Numerous taxonomies in pattern recognition have been presented. The pattern is typically tough to classify the pattern when it doesn’t belong to domain knowledge as there is no prior knowledge present to extract or recognize.

## The steps require for pattern recognition: -

1. **Sensing:** A very first step of pattern recognition is to measure the pressure, position, and temperature i.e., sense the pattern by extracting the knowledge from the domain knowledge.
2. **Segmentation:** Now Segmentation as the name suggests that segment of data, is the process of segmentation where the data is partitioned into multiple segments, and based on this segment the pattern is gone to be recognized as each data frame will match the extracted feature.
3. **Feature Extraction:** It starts from the initial set of the measured data and makes some desired values that are informative and nonredundant.
4. **A Descriptive Algorithm:** The aim is to provide the desired output for all possible inputs and perform matching of inputs.

* + **Classification:** It is a supervised machine learning algorithm that is used to identify the class of new observations based upon the given dataset. In this, the model learns from the training dataset as inputs are labelled with the output data. The data is classified as classes and based on this the label is assigned to that class.
  + **Pre-Processing:** The pre-processing process is to used segment the interesting pattern from the background. Generally, in this step, we do noise filtering, smoothing, and normalization. It first read the pattern then resize the pattern and afterward it processes filtering and gets the interesting pattern from it to recognize it.
  + **Post- processing:** It deals with the action decision-making which is given by the classification process. Actions like minimizing the cost and error rate of the model.

1. **A Training Set:** The Training set is divided into training data and a testing set to test the output of the inputs.



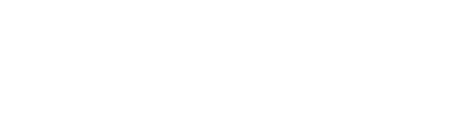
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Sensing



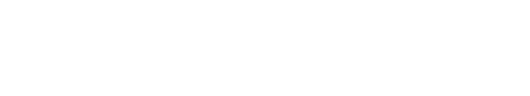
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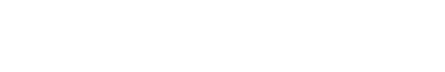
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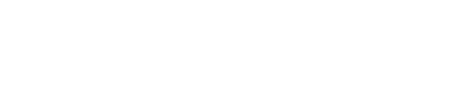
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Classification



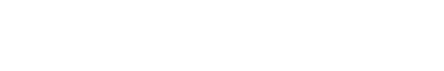
Learning



Post

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Processing



Cost

## Different Method & Algorithm for pattern recognition :-

Pattern recognition helps us to find description, grouping, and classification inside any patterns. Pattern recognition could be Supervised learning or Unsupervised learning based on different method or approaches to find patterns. Supervised and unsupervised learning also based on different types of learning procedure to produce the output. Supervised pattern recognition train model based on trained dataset or label to produce the pattern finding where unsupervised helps us to make clusters to find patterns. We can further classify the pattern recognition method into 6 types.

1. **Statistical technique** :- Statistical pattern recognition uses statistic mathematical method for analysing the data to extract required information which makes justified decision. In statistical method we group the pattern into required feature which helps us to create the n-dimensional space of pattern. The n-dimensional space use to find the how pattern forms different classes. This method takes a set of training pattern for each class which uses in our model to build different decision boundaries which will find different feature pattern in n-dimensional space .
2. **Syntactic Technique:-** Syntactic Pattern Recognition, also known as SyntPR, is used for recognition problems which involves complex patterns that uses hierarchical approach. Syntactic technique is also called structured technique because this approach based on primitive sub-patterns. Syntactic technique is use for classification and it also provide the features of how any pattern is constructed from primitive sub-patterns. Syntactic technique required large training sets and large computational efforts because this approach is combinatorial explosion of probabilities.
3. **Template Matching:-** It is most primitive method of pattern matching and one of the simplest methods compare to rest technique. In this technique we compare two images to identify the similarities and similar feature group in images after that we stored the matched pattern in templates. The templates further used as a training data; it means our model is fully relies upon stored dataset that is template. This method is not so efficient when we work with distorted patterns.
4. **Neural Network Approach:-** Till now we understand the different approaches in pattern recognition like statistical technique which is based on supervised learning and syntactic approach which is based on primitive sub-pattern, Now we will understand the importance of neural network approach in Pattern recognition. As we know neurons are the basic unit of brain which create large connection of neurons or neurons circuit, that is responsible for task done in brain. It is also called Artificial neural network which works as a simulation of human biological neural network. Neural networks have vast parallelism which makes them super-fast and efficient to make decision like human biological neurons, this parallelism is achieved by well-connected neurons circuits. Neuron store different weights from that they learn and train them self. The backpropagation technique is used to train or finding the fine-tuned parameters for any neural network. The major application of neural network is finding pattern like. In face recognition we use neural network method to recognise face. There are many applications of neural network like speech recognition, fingerprint identification and many more. Neural network is a deep learning method which is very powerful for pattern recognition.
5. **Fuzzy Model:-** In 1965 Lotfi Zadeh introduced Fuzzy set , his motive to combine the mathematical modelling and knowledge of human into one concept. The concept of fuzzy logic covers the wide area of mathematics, science engineering and logic to traditional. Fuzzy logic is also known as many-valued logic in which the truth table value is real number between 0 and 1. It is similar Boolean logic which is either completely True or False. As we know pattern recognition first find the attribute vector and then feature vector of every dimension is measured. Many time feature vectors are quantitative or rest time it is qualitative. Choosing the set of ideal feature vector is the biggest problem in pattern recognition, still there is no exact predefine rule for choosing the feature vectors for different object and group of objects. To overcome from that type of problem we come up with Fuzzy logic model in pattern recognition. Fuzzy logic pattern recognition system provides the fuzzy membership values to all classes for every objects. Fuzzy logic has fuzzy classification as compare to supervised classification and fuzzy cluster compare to unsupervised clustering. Both use fuzzy logic method to help in finding pattern recognition.
6. **Hybrid Model:-** In field of pattern recognition, we done large number of research and develop multiple different approaches, Hybrid model of pattern recognition aim to make uses of all correct paradigms approach in single method. In simple words we can say that hybrid pattern recognition model is the combination of all advantages of different approaches for pattern recognition in one single frame to produce more efficient and powerful model for pattern recognition. For example, Neuro-Fuzzy systems which is used for fuzzification of neural network for classification problem, combining the neural network and Hidden Markov Models.

# CONCLUSION :-

Pattern recognition is very fast developing domain, but still a lot research in needed, Pattern recognition have potential to solve big challenges of humans, We need to learn how to resolve the problems of pattern recognition research and find out the ways to overcome from limitation of pattern. Computation problem is the still biggest problem in pattern recognition including the feature selection. We need to learn from human biological neural network which is naive base of pattern recognition. Deep learning also plays a vital in pattern recognition and with the development in deep learning algorithms we can explore more gates of solution in pattern recognition. But apart from all of these we can sure about that pattern change the today technology era and in future going to contribute a lot.