Application of Pattern Recognition

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Abstract:

Since our early childhood, we have been observing patterns in the objects around us toys, flowers, pets, and faces. Pattern recognition has become more and more popular and important to us since 1960's. Pattern recognition aims to classify data (patterns) based on either a priori knowledge or on statistical information extracted from the patterns. This paper apply review many applications of pattern recognition and elaborate in some of them, considering present applications form different area. In this paper Pattern recognition was introduced including its concept, and method. This paper will show application of pattern recognition in robotic, biomedical, social media intelligence and Cyber security.

Keywords:

Pattern Recognition, Definition, Application, robotic, Image processing, computer-aided detection, social media intelligence, Cyber security.

Introduction:

Pattern recognition (PR) can be define as the process of classification that aimed to extract patterns from a data set and categorize them into different classes [1].Also, can be identifies as the study of how machines can examine the environment, learn to distinguish patterns of interest from their background to make reliable and feasible decisions regarding the categories of the patterns [2]. Over the years, several definitions of PR have been provided. Pattern Recognition is important because it is a need that appears in many practical problems. We as humans do this very well, but getting a computer to do the same is complicated.

The main purpose of a Pattern recognition system is to analyze given data and describe a scene in the real world which is useful for the accomplishment of a certain task.

Pattern recognition include a lot of methods which impelling the development of numerous applications in different filed.

Pattern Recognition System:

Pattern recognition as a field of study developed significantly in the 1960s. It is an interdisciplinary subject, covering developments in the areas of medical, engineering, computer science, psychology and physiology, among others.

A pattern is an entity that could be named, like fingerprint image, handwritten word, human face, speech signal, and DNA sequence [3] [1].

In general, a pattern recognition algorithm or system has three steps take place in pattern recognition task. First step is data acquisition. Data acquisition is the process of converting data from one form (speech, character, or pictures) into another form which should be acceptable to the computing device. Second step is data analysis. After data acquisition the task of analysis begins. During data analysis step the learning about the data takes place and information is collected about the different events and pattern classes available in the data. Third step used for pattern recognition is classification. Its purpose is to decide the category of new data on the basis of knowledge received from data analysis process.
A classifier basically implements a decision rule that maps the features into one of the several label. The basic pattern recognition step shown in the next figure:

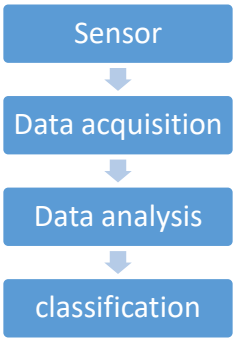


Figure 1: Basic Pattern Recognition Step

Various artificial intelligence techniques such as artificial neural network and fuzzy logic are used for classification [4] [5].

Some modern approaches to pattern recognition include the use of machine learning, due to the increased availability of big data and a new abundance of processing power. New machine learning is deep learning.it is widely used since it process wide range area data with less contributions of human and more accurate data [6] .Machine learning can be useful in improving Pattern Recognition systems, but not all pattern recognition algorithms use Machine Learning algorithms. Most public types of learning procedure are supervised learning and unsupervised learning. The classifiers that contain the knowledge of each pattern category and also the criterion or metric to discriminate among patterns classes, belong to the supervised learning. While, the unsupervised learning in which the system parameters are adapted using only the information of the input, it attempts to find inherent patterns in the data that can then be used to determine the correct output value for new data instances [7].

An example of pattern recognition system that use in speech recognition is in the below figure:

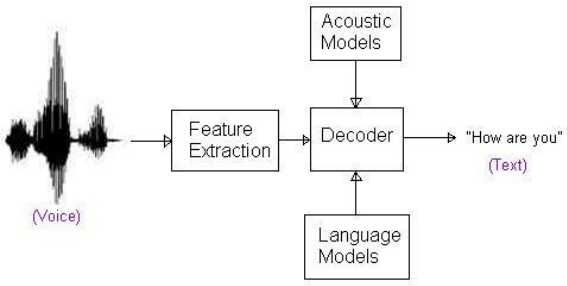


Figure 2: speech recognition system

Here we use pattern recognition with supervised learning dealing with unstructured data, the voice.

Basically, Pattern recognition is a very general technology useful for the automatic detection and classification of patterns in data. As such it can be used in almost any application of intelligent sensors as well as in all areas of research that need to find regularities in observations.

This paper clue the development of the pattern recognition through time, and its wide range of application.

This paper is structured as follows: Section 2 describes the related work. While section 3 shows different application of pattern recognition in general and show details of pattern recognition applications for particular areas. Finally, Section 4 concludes the paper.

Related Work:

In the field of pattern recognition, several studies have been conducted through the years.

At 1973(Dude and Hart) defined the pattern recognition is a field concerned with machine recognition of meaning regularities in noisy of complex environments [4] .

1992 (Schalkoff) defined PR as “The science that Corresponding to classification or description the measurement [8].

Moreover, at 2003 (Sergios Theodoridis) defined Pattern recognition as a scientific discipline whose aim is the classification of the objects into a lot of categories or classes. He see that Pattern recognition is also an integral part in most machine intelligence system built for decision making [9].

(Kaur) said that Pattern recognition is used in many fields and in many ways. It helps in digital image processing and recognize the patterns. And those can be done by using many techniques and approaches [5].

According to Random House Dictionary, the field Pattern Recognition refers to the “automated identification of shapes or forms or patterns of speech.” Since the development of acoustic sensors, imaging cameras, and other signal/image recording devices, this field has been one of the most studied fields in electrical engineering, mathematical statistics, and computer science with wide ranging applications in medicine, document” [10].

The social network in the recent years has applies the pattern recognition in wide range, Amartya discuss the Information Diffusion on Twitter with pattern recognition. It said characterizing, predicting, and quantifying the impact of postings, tweets, or messages .On social media platforms is a topic of growing interest due to the increasing reliance on using social media as a means for various purposes by individuals and organizations alike .One of the objectives of his research is analyzing the pattern of information diffusion on Twitter [11].

Pattern recognition application:

This section aimed is to deepen the understanding of different areas of PR applications, taking into account only four domains. Since PR involves various research areas, the choice of these four areas arose from the fact that they encompass most different fields of research, putting in evidence the multidisciplinary aspect of PR applications. Those area are robotics, biomedical, social media intelligence and cyber security.

Robotics:

In the present day robots and robotics has evolved a lot and it is one of the most lucrative fields in all the disciplines of engineering. Today the robots are being provide with intelligence and also better communication and efficient working. Robotics involves design, construction, operation, and use of robots.

The goal of robotics is to design intelligent machines that can help and assist humans in their day-to-day lives and keep everyone safe.

Robotics draws on the achievement of information engineering. Today many robot are used in dangerous environments including inspection of radioactive materials, and detection. To help the robot perform its role, it must has sense like touch, sensing, and vision. Here we discuss the used of pattern recognition in Computer vision , which is the technology help machines see.

Computer Vision:

As a scientific discipline, computer vision is concerned with the theory behind artificial systems that extract information from images. The image data can take many forms, such as video sequences and views from cameras [12].

Computer vision systems rely on image sensors which detect electromagnetic radiation which is typically in the form of either visible light or infra-red light.

In Computer Vision, computers or machines are made to gain high-level understanding from the input digital images or videos with the purpose of automating tasks that the human visual system can do. It uses many techniques and Image pattern recognition is just one of them .Image pattern recognition is the field of enhancing the images by tuning many parameter and features of the images.

Actually, Image pattern recognition is the problem of exploring how to recognize image patterns. An image pattern recognition system generally consists of four parts: a camera that acquires the image samples to be classified, an image preprocessor that improves the qualities of images, a feature extraction mechanism that gains discriminative features from images for recognition, and a classification scheme that classifies the image samples based on the extracted features.

Image recognition has grown so effective because it uses deep neural network .This is a machine learning method designed to resemble the way a human brain functions. That’s how computers are taught to recognize visual elements within an image. By noticing emerging patterns and relying on large databases, machines can make sense of images and formulate relevant categories and tags, as shown in the below figure:

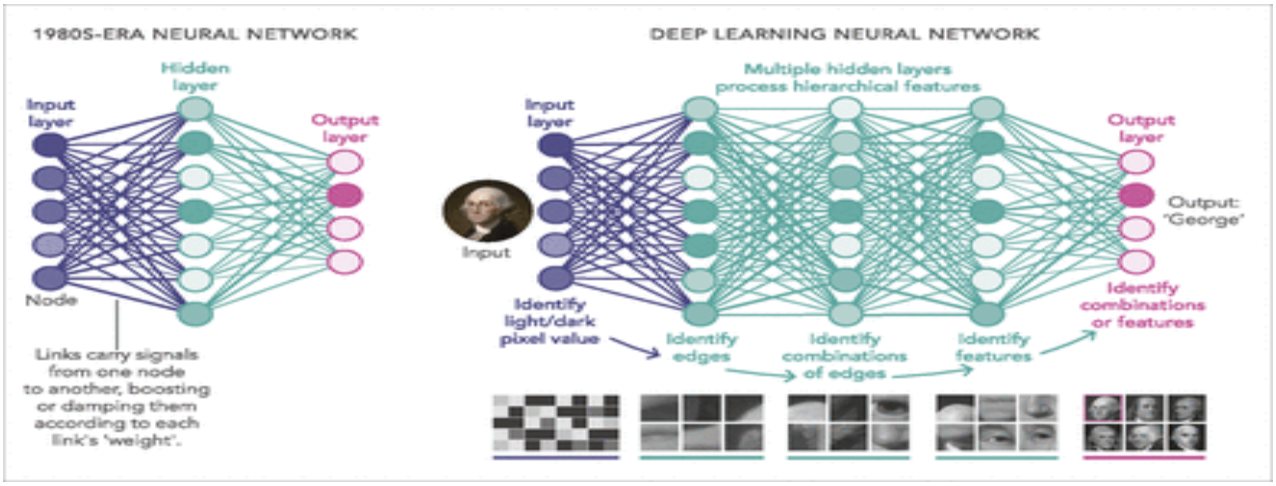


Figure 3: Image recognition

An image pattern recognition has wide range of usage like face recognition.

An application to this if the sensor detect a face and want to classify its gender. The ducted image will be processed and feature extract then will pass to the classifier to label it as a male or female. Below a figure show the different in male and female feature [13] [14].

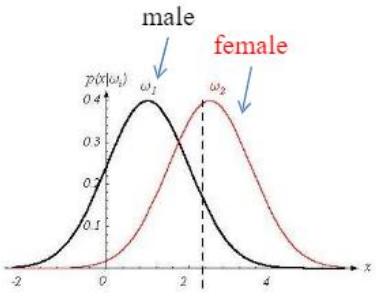


Figure 4: classify gender based on face recognition

Biomedical and biology:

Biomedical includes those science disciplines whose primary focus is the biology of human health and disease [15].

The history of the relationship between biology and Pattern Recognition is a long and complex one. Actually, Biological research can be considered an explosive expansion of big data providing enormous opportunities for research, like precision medicine.

The biomedical sciences characteristically deal with huge masses of data, which must be organized, reduced, analyzed, and generally processed in many different ways. Much of this data is in the form of pictures:

photomicrographs, electron micrographs, X-ray films, X-ray diffraction n patterns, autoradiographs, time-lapse films, or cineradiography. Individual pictures hold a great wealth of precise numerical information, such as the morphological and structural characteristics of lengths, areas, volumes, and densities. From sequences of pictures, quantitative results can be derived, such as the kinematic and dynamic characteristics of trajectories. Image based medical diagnosis is one of the important service areas in this sector.

Most of these computer-based systems are designed by using artificial neural network techniques [3].

Below listed is the some of the contributions of pattern recognition in health and medicine domain:

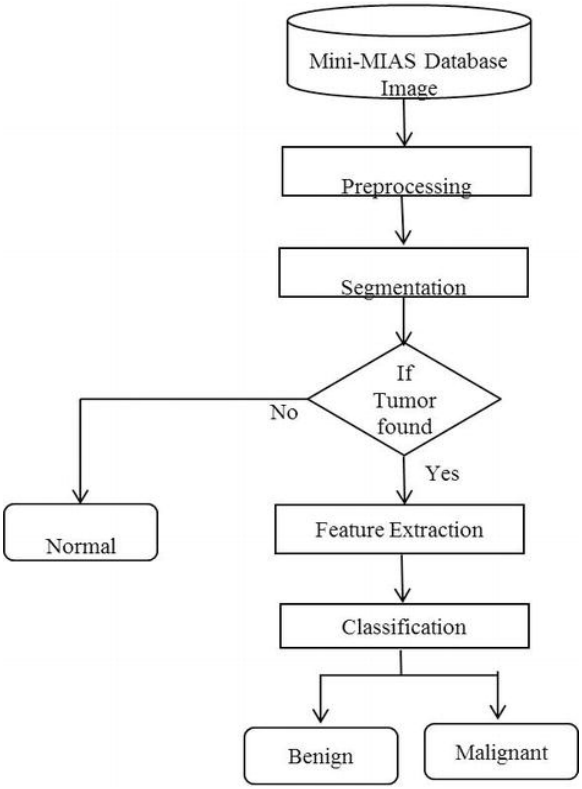
Clinical decision support systems (CDSS) were one of the first successful applications of AI, focusing primarily on the diagnosis of a patient condition given his symptoms and demographic information. Work on CDSS for medical diagnosis began in the early 1970s with Mycin3-a rule based expert system for diagnosing diseases.

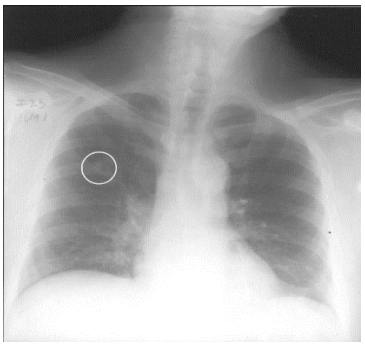
Pattern recognition has also been useful for computer-aided detection (CAD) of conspicuous structures in medical images. CAD are systems that assist doctors in the interpretation of medical images.

A typical application is the detection of a tumor. For instance, some hospitals use CAD to support preventive medical check-ups in mammography (diagnosis of breast cancer), the detection of polyps in the colon, and lung cancer.

Usually CAD confined to marking suspicious structures and sections. Usually focused on to classify detected structures or regions by Preprocessing (noise reduction and enhancement) and then Features selection and classification.

CAD systems fundamentally work on highly complex patterns found in image. As an example, for breast cancer, it is used in screening mammography. Next figure explain the steps CAD Used to chive its role and sample for mammography photo [16].





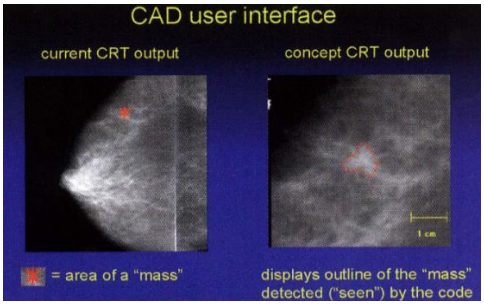


Figure 5: CAD system

Another system use pattern recognition is Content-based image retrieval (CBIR).Which is an alternative and complementary approach for image retrieval based on key-words and metadata. Initial results are very promising about using CBIR as a diagnostic support tool (CBIR).

CAD and CBIR will be employed as useful tools for diagnostic examinations in daily clinical work [17].

A pattern recognition has it applicant in DNA sequences analysis, with more evolution in pattern recognition and its techniques will get better and more useful application in biomedical field.

Social media intelligence (SMI):

The term "social media intelligence" was first used by David Omand, Jamie Bartlett, and Carl Miller at Demos, a London-based think tank. They explored the term for the Centre for the Analysis of Social Media (CASM) in a 2012 paper. In the paper, they discussed how intelligence is the key to social media, and how social media intelligence is an expansion.

Social media intelligent mainly divided into three stages: listen, analyze and act. So they listen to the user from their picture, post, and search. Then, analyze it using pattern recognition and machine learning to understand under which category the user classify and what their need. Last they act by putting suitable ads to the most suitable audience. Also, they will try to get the users attention by know their interest and make them spend more time in the social media. This is show the commercial goal.

Moreover, it has its own usage on national security. An example, detect the possible religious extremists, criminal, or civil unrest threat. More usage for the SMI is community services as they try to detect and prevent inappropriate content. With the large variety of social media channels, there is a huge amount of data available. The challenge is accessing these data and transforming them into something that is usable and actionable [18].

Without social media intelligence, businesses cannot leverage the power of their social data. You will be surprised how your favorite social media service and application are using pattern recognition and machine learning. They use data gathering Analyzing text, and analyzing pictures. Here, will discuss one famous social service using SMI.

Facebook is the leading social media platform when it comes to cutting edge technology that re-purposes user data across hundreds of thousands of experiments broken down into millions of accounts.

Each day Facebook collects tons of data. This data brings value to the company and gives responsibility to Facebook.

Facebook is using face recognition to find users in a picture that they are not aware of. This also helps you to find Catfish (People creating a fake account with your profile picture).

Actually, Facebook created a tool called Deep Text. This tool helps the company to

recognize the meaning of conversations on the platform. Understanding the topic can lead to a more accurate advertisement to the users.

With the same tool, Deep Text, Facebook can recognize, for example, posts that would represent suicidal thoughts.

Deep Text, includes multiple tasks, such as general classification in pattern recognition to determine what a post is about — basketball, for example — and recognition of entities, like the names of players, stats from a game, and other meaningful information. To get closer to how humans understand text, they add pattern recognition with machine learning [19] [20].

Using deep learning in pattern recognition, we are able to understand text better across multiple languages and use labeled data much more efficiently.

With the aid of an analysis based on human moderators, Facebook can send ads with suicide prevention materials to these specific users.

Looking at the bigger picture, this would help Facebook last longer and create a deeper impact upon the users. If it will understand you better, it will show you more interesting content and you'll spend more hours on Facebook [21]

Of course, the privacy implications might rattle some people. Facebook is now highlighting that it scans the content of your private messages.

Almost, all the social network application used pattern recognition as twitter and Instagram.

Nowadays , social networks has become one of the most important means of communication-itis used as a major tool for viral marketing, political messaging, opinion formation and many other things. So, the used and need of pattern recognition will increased rapidly [11].

Cyber security:

Cybersecurity is the ongoing effort to protect these networked systems and all of the data from unauthorized use or harm.

Confidentiality, integrity and availability, known as the CIA triad is a guideline for information security for an organization. Confidentiality ensures the privacy of data by restricting access through authentication encryption. Integrity assures that the information is accurate and trustworthy. Availability ensures that the information is accessible to authorized people [22].The next figure show the CIA of cyber security.

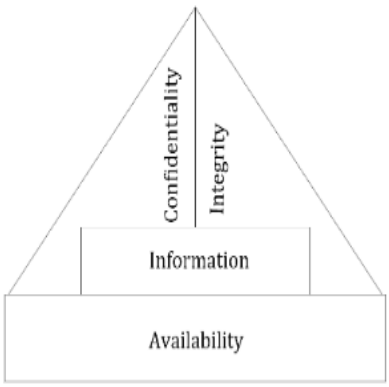


Figure 6: CIA security principle

Computer Security deals with the detection and mitigation of threats to computer networks, data, and computing hardware.

Malware, malicious, is any software intentionally designed to cause damage to a computer, server, client, or computer network. Programs are also considered malware if they secretly act against the interests of the computer user [23].

Currently, it is common for malicious software such as computer viruses and worms to affect a computer such that it will not behave as expected. Malicious software can delete files, slow computer performance, clog e-mail accounts, steal confidential information, cause computer crashes, and allow unauthorized access. Generally perform other actions that are undesirable or not expected by the user of the computer. To protect the computer and network from them, it need to know about each software and decide is it malware or not.

Since the human doesn't has the ability to access big amount of data within short time, the need of automated way was arise. Here Pattern recognition used to get the access to the similarities and differences within data set and report any anomalies.

The classification algorithm outputs a classification label for the suspect software, identifying it as malware or not.

A malware classifier uses features of suspect software to classify the software as malicious or not. The classifier uses a pattern classification algorithm to statistically analyze computer software. The classifier takes a feature representation of the software and maps it to the classification label with the use of a trained model. The feature representation of the input computer software includes the relevant features and the values of each feature. These features include the categories of: applicable software characteristics of a particular type of malware, and function name strings typically occurring in the body of the malware; and other alphanumeric strings commonly found in malware. By providing these features and their values to the classifier, the classifier able to identify a particular type of malware. Next figure show the main step in classification a software:

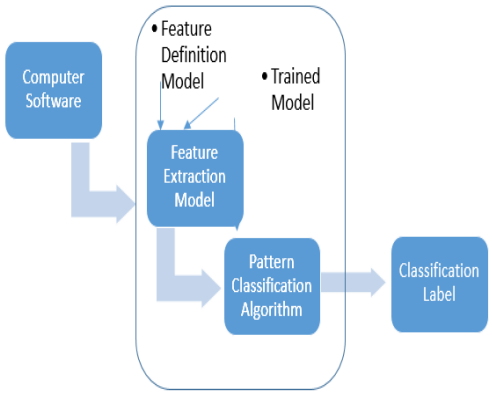


Figure 7: classification step of malware software

The need of training model is arise. Figure 8 is a block diagram illustrating the creation of trained model. Training application depends on feature definition file and includes feature extraction module. Training application takes both normal computer software and a particular type of malicious software as training data and, after computation, outputs the trained classification function in trained model [24].

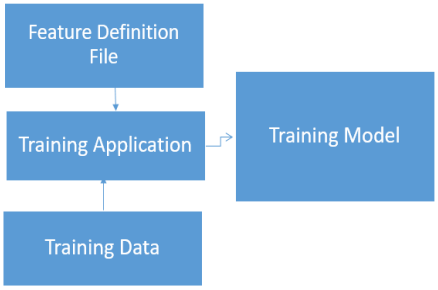


Figure 8: Training model techniques for malware

Another application related to cyber security with pattern recognition is Spam Assassin, which is a computer program used for filtering. The program can be integrated with the mail server to automatically filter all mail for a site. It can also be run by individual

users on their own mailbox and integrates with several mail programs. It make feature list to classify if email spam or not.

A lot of application are available to cyber security with pattern recognition. Actually Strong AI technique with cyber security may be expect the threat before happen [25].

A general look for Pattern recognition will implies that it is not a new problem. Several studies have been conducted on this topic, a lot of research has currently taken place and thousands of applications are there in different area. Below a short list of application as an example to show wider look for pattern recognition application in some area:

- Speech recognition

Human computer interaction

(Microphone records acoustic signal then

Speech signal is classified into phonemes and words)

- Safety

Face recognition [26]

Identifying fingerprints

- Astronomy

Classifying galaxies by shape Astronomical telescope image analysis Automatic spectroscopy

- Agriculture

Output analysis Soil evaluating Extraction mineral characterization in coffee and sugar [27].

- Geography

Earthquake analysis Rocks classification

- Engineering

Fault diagnosis for vehicle system

Recognition of automobile Type

Improve the safety performance of automobile

- Military

Affairs Aviation photography analysis

Automatism Aim recognition

Conclusion:

In its broadest sense pattern recognition is the heart of all scientific inquiry, including understanding ourselves and the real-world around us. It solves many problems like categorical problem, and identify a specific object .The developing of pattern recognition is increasing very fast as the related fields and the application of pattern recognition became wider and wider.

But there's a limitation, and even a downside to good pattern recognition since finding simple pattern recognition of things in is not a guarantee. Also, pattern recognition sometime is difficult to execute and slow .It requires a bigger dataset to acquire enhanced accuracy [28].

This paper overview the pattern recognition in the round, include the definition of PR, the methods of PR, and the application of pattern recognition. Although of its limitation in some aspect, pattern recognition are delivering a promising solution to develop systems and to enable the rapid acceleration of innovation.

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