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**Pattern Recognition**

### 1) Introduction

Pattern recognition is a broad term that can encompass many different types of algorithms depending on what the program is doing. It is a data analysis technique that uses machine learning to recognize patterns in data. In more human terms, the program takes an input and examines the data based on comparisons of samples. Then through probability it narrows down possible answers and tries to classify what the data could mean or be. There are many different types of these algorithms because there are many different types of data. Take for example images, sounds, text, or any other type of data. An image pattern recognition program could determine whether or not the person shown one photo is the same in a different photo. On the other hand, a text recognition algorithm can read hand-written words and translate them to computer text. These algorithms are not only important for general and daily use, but they also have a significant impact on the future of artificial intelligence.

### 2) History / Motivation

The term "artificial intelligence" was not introduced until 1956 when a group of ten scientists at a Dartmouth College conference popularized the term and essentially founded the field of AI. Their original hypothesis was that any aspect of learning or human intelligence can be simulated through computers. In the early stages of development behind the idea not much promise was shown, but as the years went on these algorithms began to do much more.

A great example of a concrete breakthrough of this would be from the game of chess. It was believed that no artificial intelligence could ever beat the smarts of a human chess player. In 1997 this changed when IBM's Deep Blue Computer took down world champion chess player Garry Kasparov. The AI that did this not only understood how to play chess but was actively analyzing their opponents playstyle through pattern recognition. The AI was making decisions like a human would, but even better. The further development of AI led to voice recognition, video game AI being able to control bots, and even shopping suggestions based on user searches and previous purchases.

Optical Character Recognition (OCR) is a type of AI that digitally came together in the 1970s by Ray Kurzweil. He later sold this to Xerox in the 1980's to commercialize the product.

### 3) Overview of Working Algorithm

Let's take a look at one of the more simple AI pattern recognition algorithms: handwriting recognition, aka OCR. The problem here is that everyone has their own unique style of handwriting, but modern day OCR is up to 99% accurate. The algorithm is shown a piece of handwritten paper and its task is to translate this image into readable text on the computer. The algorithm is split into two main sub-tasks: a training phase and a classification phase. The program will compare the given handwriting to examples of other text it has stored on file, and then classify each character as one single letter or number. Some programs have up to 100,000 examples to compare to. The program will classify based on which character is the "closest neighbor" to the example. This means whichever character is closest in comparison to the example based off of percentages will be selected. This results with readable text that the computer can analyze for other tasks.

Take for example the letter "a." The program will compare this character to every single example among the 100,000. By comparing, the program will line up the hand-written character behind the example character, essentially putting the two right on top of eachother. This can be visualized as two separate small spaced 2-dimensional planes holding only one character stacked on top of eachother. The program can loop through these planes and ask if there is equal space between the two. It will then give a percentage of how close it is to every character based off of the overlapping space between the two. So the example handwriting "a" might have a 75% match to the number "2," but the 98% match to the letter "a" will override this and therefore it will be classified as the letter "a."

**4) Applications**

Text recognition is only one example of pattern recognition AI, but it can be applied to so many other different fields of work. It is very relevant in today's modern day world of technology. The market size of Optical Character Recognition is expected to be worth $13.38 billion by the year 2025. This AI is used widely for healthcare and pharmaceuticals, insurance, banking, and libraries. An insurance company receives up to 20 million papers or more in a day, and they must be sorted effectively and efficiently. The same applies for healthcare and libraries especially. There is a huge amount of historical data being uploaded to library databases that has to be sorted correctly. Have you ever deposited a check by taking a picture of it on your phone? Or have you ever wanted to translate some writing you found by taking a picture of it? These both rely concretely on this algorithm, and so do all of these other companies on a daily basis, they would be extremely inefficient without it.

## 5) Why is this algorithm important?

Before this algorithm was invented a human would have to do this work, like if a blind person wanted to read, someone would have to do it for them. That was until in 1913 when England's scientist Edmund Edward Fournier d'Albe invented the optophone. It was an analog computer that used photo sensors to look for black print and would then convert it into words playing them aloud. The machine was too slow and expensive for any commercial use, and OCR did not see any real improvements until the 1970s. Today's solution is much better and way more efficient than the optophone. The amount of time it would take for a human or the optophone to translate an entire library database of written text into computer text is far greater compared to the time an OCR program would take to do so. Today's newest OCR algorithms are almost 100% accurate and are used all over the world. It is not only used for form analyses by many insurance, healthcare etc. companies, but it is also an accessibility feature.

## 6) Analysis

At the moment, OCR and even digital computers are going to be reaching their limits before we know it. What's the next step? Machine learning allows this algorithm to work, but computers today are striving for more than this. The future of OCR is held in AI deep learning. A deep learning AI will supposedly mimic the neural network of a human brain, allowing for human-like intelligence. Instead of only translating writing into text, this AI could make even further analyses based on the information, and attain meaning from it like a human would. For example, once this AI translates all the insurance companies' forms into computer text, it will look through them in a very quicker manner. After this it can conclude important information and statistics based on the data like a human would conclude. As different researchers improve this

technology, the competition will be based on who's software provides the best insight from data in the most efficient manner.

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