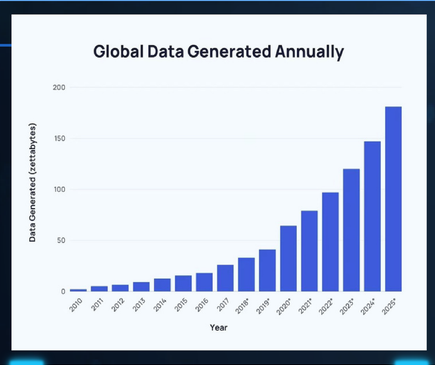
A Primer on Machine Learning

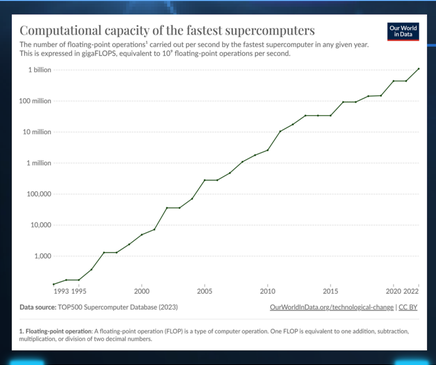
— for 16-year-olds still on the fence about A level subject choices

Introduction

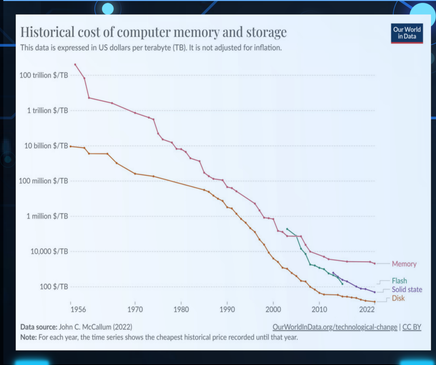
The earliest machine learning algorithms date back to the early 1900s, and more than 100 years have passed since then. However, looking back at history, for most of the time, machine learning only existed in research projects with very limited practical applications and virtually no economic or social impact. But just in the last few years, machine learning has suddenly hit the big time and attracted a lot of attention. This situation is mainly attributed to three factors.



The rapid growth of data provides a wide variety of opportunities for machine learning applications.



The Growth of Computing Power makes it possible to process and analyse large amounts of data.



The reduced cost of computer memory and storage allows machine learning to be applied to the real world in a cost-effective way.

> "A baby learns to crawl, walk and then run. We are in the crawling stage when it comes to applying machine learning."
>
> **— Dave Waters**

Although machine learning algorithms have been studied for many years, for the application of machine learning, there is still a vast space waiting to be explored.

Machine Learning for Biometrics

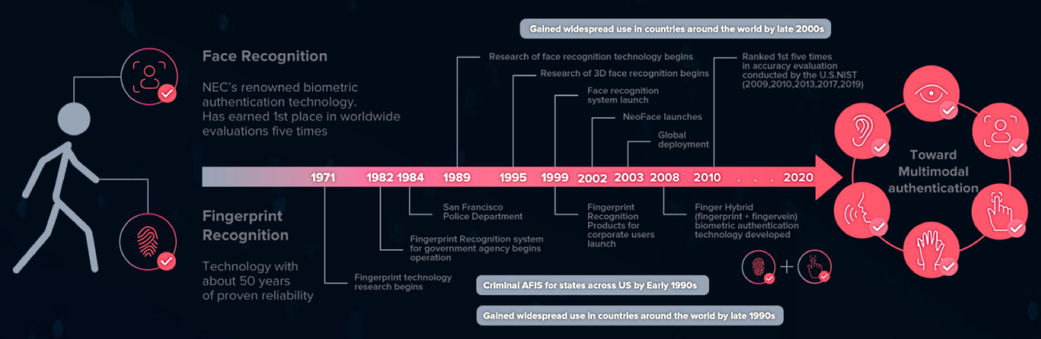
One of the most notable machine learning applications is image Biometrics. So in this part, we will focus on this application scenario.

Biometrics is the measurement and statistical analysis of people's unique physical and behavioral characteristics. The term "biometrics" is derived from the Greek words "bio" (life) and "metrics" (to measure). So it means the measurement and statistical analysis of people's unique physical and behavioral characteristics. Many of these new automated biometric are based on ideas that were originally conceived hundreds, even thousands of years ago. But they have only become available over the last few decades, due to significant advances in the field of computing.

Here are some common examples of biometric security:

- Fingerprint Scanning
- Iris Recognition
- Voice Recognition
- DNA Recognition
- Facial Recognition
- Signatures Recognition

While it may seem like a relatively new concept, as I mentioned above, biometrics has actually been around for centuries. Among them, the oldest examples of characteristics that are used for recognition by humans are faces and fingerprints. Since the beginning of civilization, humans have used faces to identify known (familiar) and unknown (unfamiliar) individuals. There is also evidence that fingerprints were used as a person's mark as early as 500 B.C. "Babylonian business transactions are recorded in clay tablets that include fingerprints."



Then, how machine learning is being applied to facial recognition and fingerprint recognition?

Primarily, a facial recognition system or fingerprint recognition system involves four processes: Image acquisition, image processing feature extraction, feature value comparison, and individual identification. Therefore, it's easy to see that this is actually a process of image recognition. When it comes to image recognition, we have to mention Convolutional Neural Networks (CNN), which is a type of deep learning model that has become dominant in various computer vision tasks.

Convolutional Neural Networks is a mathematical construct that is typically composed of three types of layers (or building blocks): convolution, pooling, and fully connected layers. The first two, convolution and pooling layers, perform feature extraction, whereas the third, a fully connected layer, maps the extracted features into final output, such as classification.

Convolution layer

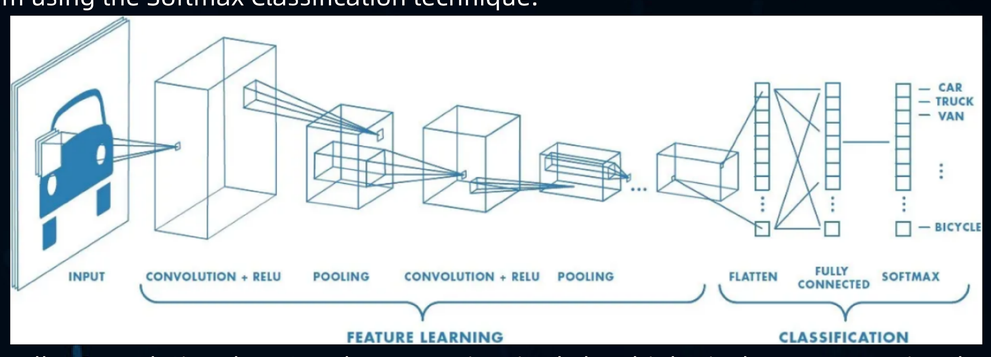
A convolution layer is a fundamental component of the CNN architecture , where the most important step is to perform a convolution operation. The objective of the Convolution Operation is to extract the high-level features such as edges, from the input image. Thus, the role of the convolutional layer is to reduce the number of parameters while preserving the spatial structure information of the image.

Pooling layer

Similar to the Convolutional Layer, the Pooling layer is responsible for reducing the spatial size of the Convolved Feature. This is to decrease the computational power required to process the data through dimensionality reduction.

Fully connected layer

Fully connected layers are usually found in the last layers of a neural network and are used to output the final predictions of the model. The output feature maps of the final convolution or pooling layer is typically flattened, which is fed to a feed-forward neural network and backpropagation is applied to very iteration of training. Over a series of epochs, the model is able to distinguish between dominating and certain low-level features in images and classify them using the Softmax Classification technique.



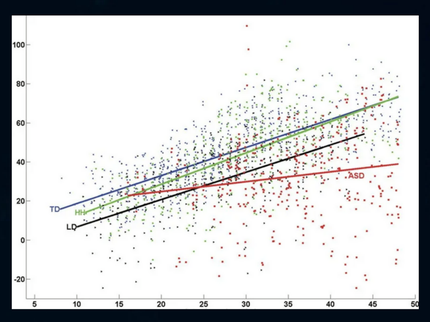
Overall, Convolutional networks were inspired by biological processes in that the connectivity pattern between neurons resembles the organization of the animal visual cortex. Individual cortical neurons respond to stimuli only in a restricted region of the visual field known as the receptive field. The receptive fields of different neurons partially overlap such that they cover the entire visual field. In simple terms, just as our brain recognizes objects by focusing on a small part of our field of vision, convolutional neural networks mimic this mechanism to help computers better understand and process image data.

What can machine learning give you?

Mastering Machine Learning will allow you to become a Machine Learning Engineer, a Natural Language Processing Scientist, an AI Engineer or a Data Scientist in the future. All of these positions are lucrative. But doesn't it sound a bit boring if machine learning can only get you a job?

Let me share an example with you. Have you ever felt that the films recommended to you by video software often don't suit your preferences. If you happen to have mastered machine learning at this point, you can build a predictive model of your own.

First you collect as many movies you've seen as possible, along with their relevant information such as title, film origin, director, budget, release date, and, more importantly, the ratings you have for them. Then for this data, you can use a multiple linear regression algorithm (as shown in the right figure) to build a predictive model. Having done this, in the future, when you come across a film you're not sure you want to see, you can put the film information into the model and get a predicted score specific to you.



Does hearing this example inspire you? If so, you can share it with us:

If you mastered the technology of machine learning, what would you do with it?