FirstRand

Medicine, Pigeons and Pattern Recognition

Author: Rachel Edelstein

Pattern recognition is the automated recognition of regularities in data. In recent years, and particularly with the development of artificial intelligence and machine learning, it has become significant to many industries.

But what exactly is pattern recognition? How is it relevant in the medical world and not just in the technical one? Pattern recognition is enabled through, among other technology, a mechanism called deep neural networks (DNNs). These DNNs are built with the intention to 'simulate the behaviour of the human brain' through a combination of data inputs, weights, and biases, as explained by IBM. While this may sound a lot like machine learning, machine learning relies on leveraging structured data, while deep learning (where deep neural networks are applied) exploits unstructured data to recognise regularities and draw relationships.

This seems irrelevant until one looks at some real-life applications, and how such technology is being used to advance certain fields of medicine.

One of the powerful tools enabled through the process of deep learning, is that an element of 'human dependency' is eliminated through the automation of feature extraction. During this practice, an initial set of data is broken down into smaller categories through the identification of distinguishing characteristics.

To give a simple example, the development of a straightforward algorithm to differentiate between types of animals would require the DNN to pay extra attention to the ears and recognise which set of ears are characteristically feline, canine and so on, rather than relying on humans to perform this simple task. This, the diminishing reliance on human intervention, is the ultimate goal in medical technologies.

A few years ago, a study showed that pigeons were able to detect breast cancer just as well as humans. The birds were taught to distinguish between malignant and benign breast tissue in scans and were rewarded upon presenting the correct answer. When the decisions of a group of four pigeons were considered, the detection accuracy reached 99% which was clearly a significant result.

The pigeons' successes suggested that they were well-suited to help us better understand human medical image perception. It showed a potential advantage for the development of medical imaging hardware, image processing, and image analysis tools. Perhaps most importantly, though, is the implication that a basic ability of pigeons to recognise patterns in data will eventually mean the decreased involvement of professionals and will subsequently facilitate growth in the field. If this is what pigeons can achieve, the implications for artificial intelligence are substantial.

In the case of such a scan, rather than identifying obviously different characteristics, such as animal ears, the deep neural network could be used to distinguished more subtle differences like malignant and benign tissue.

All of the evidence clearly points to the fact that the use of pigeons in image analysis is only one step in the right direction towards entirely removing the need to retain medical professionals for these mundane tasks.

With the development of pattern recognition algorithms in medical technology, an additional two machine learning concepts have become increasingly more significant.

A decision support system (DSS) is, much like the name suggests, an information system that aids in decision-making through judgement and access to data. A DSS will support a high-level team in navigating a mass of unstructured data and,

in the medical world specifically, aids experts in diagnosis.

The second is Bayesian Networks (BN) which have also become increasingly popular for diagnostics and other areas in the medical world. They are built as a probabilistic graphical models for the representation of data. The reason for their popularity is that, unlike many pure machine learning methods, they do not explicitly require extensive datasets. They combine the knowledge of experts with collected data when the latter is scarce. The significance of this is by incorporating both of these data forms, these networks can form a robust spine for meaningful decision support systems.

So how, then, do these BNs act as a practical support structure in medical diagnostics?

According to ScienceDirect, half of all models for lung conditions aim to calculate the risk of exacerbation of an already diagnosed condition (such as asthma). Other models use clinical indicators and symptoms to assess the probabilities of particular diseases. Here is where the BN comes in: an online application, accessible on a smartphone or laptop, could determine the patient's current condition through questionnaires and a BN model and provide direction and relevant information for diagnostics and treatment (this forms part of the decision support system). In addition, the app would deliver the patient's health status data to medical experts.

This may not even sound particularly sophisticated or inventive but here, again, it is clear how deep learning is becoming a newly central tool in medical diagnostics. Because Bayesian Networks and decision support systems incorporate both human expertise and raw data, clinicians are supported with the collaborative tool that is a reliable and efficient back-end system.

Pattern recognition in medicine, then, can be thought of as the umbrella term for all methods and systems that sort through masses of data and find regularities or conspicuous features with the intention of drawing relationships and conclusions.

Whether it be a human expert, or a technologically developed sorting algorithm, pattern recognition techniques are being used to propel the advancement, and subsequent automation, of the medical world. If pigeons can detect breast cancer, a world of great possibility exists. Just starting to think about the potential that exists within our available resources allows us to imagine the scale and capacity enabled by modern technologies and their potential impact on lasting change.