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Deep Learning techniques assisting radiologists to streamline diagnosis

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DL holds the promise of speeding up the productivity of clinical professionals- eventually resulting into better patient outcomes and reduced healthcare costs



In recent years, Deep Learning (DL) has gained significant interest in radiology across different areas of computer vision such as detection, segmentation, classification, monitoring & prediction. Deep learning, a subset of Machine Learning in AI, is based on artificial neural network and is increasingly proving to be the transformative for the healthcare industry especially due to its high performance in image recognition.

With immense potential to analyse huge volume of data generated by different devices, imaging modalities and organs, DL holds the promise of speeding up the productivity of clinical professionals- eventually resulting into better patient outcomes and reduced healthcare costs.

Traditionally, medical image processing tasks were manual, very detailed and consumed significant amounts of time of medical professionals. Human interventions were needed in every step in order to obtain the most accurate image possible. Data/Image exploration from CT-Scan, X-rays and MRI at pixels/megapixels level was challenging for clinical professionals and it was not easy to extract meaningful and hidden insights.

However, Deep Learning's capability to automate the analysis of structured & unstructured data, specially for these images, accelerates the process of extracting actionable insights with reduced human supervision.

So, What is Deep Learning and how it can help to solve some of the most pressing issues in healthcare ?

As described above, Deep learning is a subset of machine learning technique that learns and improvises on its own by examining computer algorithm based on artificial neural network which is designed to think how humans think and learn. It is witnessing an increase in success and interest in multiple domains including computer vision, speech recognition, natural language processing and games. Deep learning techniques provide a mapping from raw inputs to desired output like image classes by directly learning the features from a large set of data.

Data is filtered through a cascade of layers where each successive layer is essentially learning from the previous one, thus refining their ability to make better correlations- just the way biological neurons are connected with one another to process information in the brains of animals. This layered algorithmic structure helps deep learning models to perform certain classification tasks by analysing enormous quantities of unstructured data such as detecting subtle abnormalities in medical images, grouping patients with similar attributes into risk-based cohorts, or modelling relationships between symptoms and after-effects.

Deep learning can be applied to the entire landscape of healthcare applications ranging from one-dimensional biosignal analysis and the prediction of medical events such as:

1. Cardiac arrests and seizures
2. Computer-aided detection & diagnosis of skin cancer
3. Ophthalmologic disorders
4. Analysis of electronic health records to drug discovery.

A recent study in the *Annals of Oncology by* European Society for Medical Oncology and the Japanese Society of Medical Oncology showed that convolutional neural network (CNN), trained to analyze dermatology images, identified melanoma with 10 per cent more specificity than human clinicians. CNN is composed of multiple building blocks, typically repetitions of a stack of several convolution layers and a pooling layer, followed by one or more fully connected layers.

Every convolution operation (representing an image feature) generates a matrix, usually smaller than the input. It automatically learns spatial hierarchies of features by following a backpropagation algorithm. CNN architectures do not necessarily require a human to segment the tumours or organs and consists of millions of learnable parameters to estimate. As a result, CNNs can surpass the accuracy of human diagnosticians while detecting more complex "high-level" features in the images.

CNN based deep learning methods are increasingly being used to improve radiology practices, especially in the areas below:

1. Classify acute and non-acute paediatric elbow abnormalities on radiographs
2. Breast & lung cancer screening
3. Reducing the rate of false-positive results for ophthalmologists
4. Classifying skin lesions to brain segmentation studies

.. the list is growing rapidly with time.

While deep learning techniques show great assurance to improve patient care and enhance the efficiency of clinical procedures, there are certain limitations and technological challenges that need to be addressed. DL requires large sets of data for effective image alteration and identification and still cannot guarantee 100% accuracy. Another concern is the lack of availability of established systems to validate the DL outcomes.

The third challenge is accountability-if a doctor (with the help of DL system results) make a diagnosis that turns out to be wrong, who will be held liable? Despite these challenges, the application of deep learning in the field of medical imaging looks promising as researchers believe that these concerns will be dealt with in the years to come.

Though many of the above-mentioned use cases are small-scale pilots and still in their infancy, medical researchers predict that in the future deep learning will definitely optimize radiologist's workload and enable the detection of life-threatening diseases early. Just envisage, how intriguing it would be to predict a heart attack before it turns into a traumatic episode in someone's life. No wonder this particular industry has garnered huge interest in AI and its applications.

Deepak Jha, Deputy General Manager- AIPF (Artificial Intelligence Platform), NEC Technologies India Pvt. Ltd., Noida