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Medical Image Analysis Using Deep Learning Neural Networks

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ABSTRACT

Deep learning is a type of machine learning that can make use of either supervised or unsupervised algorithms, or both. The deep learning comes from the numerous layers that are built into the deep learning models, which are characteristically neural networks. A convolution neural network (CNN) can be made up of several layers of models, where every layer takes input from the preceding layer, processes it, and outputs it to the next layer, in a daisy-chain fashion. Hospitals are encountering an enormous invasion of large multimodality patient data to be analyzed accurately and with context understanding. Many deep learning algorithms have been developed to automatically identify the features that are characterizing the diseases depicted in medical images. Extorting the appropriate features from the medical images using advanced image or signal processing methods limits the quantity of information accessible for the deep learning algorithm. Transfer learning in deep learning process can improve existing computer-aided diagnosis methods and provides separate classifiers without huge datasets, assisting machine-learning methods in radiomics and precision medicine.

Keywords :- Deep Learning, Machine Learning, Convolution Neural Networks, Mammography Screening

I. INTRODUCTION

Machine learning, deep learning, and artificial intelligence altogether contain comparatively definite significances, but are frequently generally used to mention to some sort of modern, big-data related processing method. Deep learning is so widespread owing to two foremost reasons. First it was discovered that CNNs run much faster on GPUs, such as NVidia ‘s Tesla K80 processor. Secondly, data scientists understood that the enormous accumulations of data we’ve been gathering can assist as a enormous training corpus and thereby supercharge the CNNs into yielding significant enhancement in the precision of computer vision and NLP algorithms. Artificial Intelligence (AI) is an important field of computer science which thriving enormous research hotspots and applications. AI is an attempt of human intelligence and generates intelligent machines that process information [1]. Computer-aided detection or diagnosis has been a capable part of study over the last two decades. Medical image analysis intentions to deliver a additional well-organized analytic and treatment procedure for the radiologists and clinicians. However, with the development of science and technology, data interpretation manually in the conventional CAD systems has gradually become a challenging task. Deep learning methods, especially convolutional neural networks (CNNs), are successfully used as tools to solve this problem. This includes applications such as breast cancer diagnosis, lung nodule detection and prostate cancer localization. Medical imaging has become indispensable for the detection or diagnosis of diseases, especially for the diagnosis of cancers combined with a biopsy, and gradually become an important basis for precision medicine. Currently, imaging techniques for medical applications are mainly based on X-rays, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and ultrasound [2].

II. DEEP LEARNING AND MACHINE LEARNING

Deep learning has an important part in prediction and systematic process. It is a subgroup of machine learning and its approaches raise exploration interests as it resolves numerous problems which could not be approached before. The method of deep learning is used to recognizing patters, detecting speech, NLP (Natural Language Processing), etc. Machine and Deep learning technology showcase significant part in computer field and it performance as proficient for estimates and making decisions. Deep learning technology is a kind of machine learning technology [3]. These technologies used to abstract the data and procedure for as per requirements. The key idea of Deep learning is to acquire data illustrations by enlightening abstraction stages. Different varieties of styles for deep learning have suggested with Convolutional Neural Network (CNN), Deep Auto-Encoder, Deep Neural Network (DNN), etc. [4]. Image processing is the developing knowledge in medical field. Image processing brings significant information on result making. Several types of stages are observed on medical field afore obtaining output [5]. Medical image is given as input to the deep learning and it is partitioned into sections in order to focus on significant area. Next, those segments are used to abstract important information with the help of information retrieval methods [6]. Then the essential features are obtained without noise by means of noise removal techniques. The attained data categorized by using classifier and predictions are done by means of classification. These steps are followed for every experiment done in machine and deep learning [7].

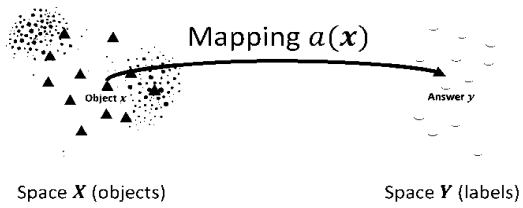

FIGURE 1: MACHINE LEARNING

Machine learning algorithms are categorized as. Supervised learning, Semi-supervised learning, Un-Supervised learning and Reinforcement learning and Active Learning Where as in deep learning, the techniques are advanced concepts of machine learning which classifies data and predictions are done accurately by using Neural-Networks [9]. Large amount of data used to build a large neural network. In the field of medical, diagnosing diseases is interesting task. The health care department gives enormous data for the assessment of medical diagnostic, patient details, treatment methods, prescriptions and supplementary data etc. [10]. These data related with inappropriate or unrelated data which is observed as the main challenge to remove. So the mining is vital to process the report efficiently and effectively. This classifier distributes the data according to its characteristics or nature. The following diagram represents the steps used in machine learning and deep learning algorithms.

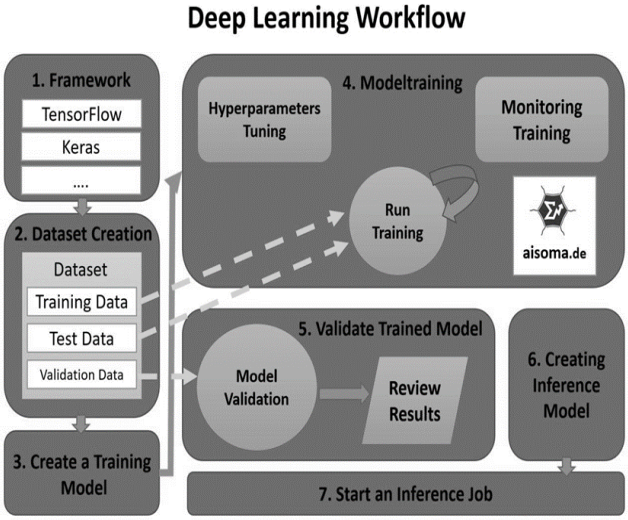

FIGURE 2: DEEP LEARNING WORKFLOW

III. CONVOLUTIONAL NEURAL NETWORK(CNN)

Convolutional neural network, a session of artificial neural networks that has developed foremost in numerous computer vision responsibilities, is interesting concern through a range of fields, comprising radiology. Convolutional neural network is considered to spontaneously and adaptively absorb three-dimensional hierarchies of structures through backpropagation by using several building blocks, like convolution layers, pooling layers, and completely linked layers. Two tasks in relating Convolutional neural networks to radiological responsibilities, minor dataset and overfitting. Being acquainted with the ideas and benefits, as well as boundaries, of CNN is vital to influence its impending in diagnostic radiology, with the area of supplementing the act of radiologists and refining patient care. Knowledge with this state-of-the-art procedure would aid not only researchers who work with CNN to their responsibilities in radiology and medical imaging, but also clinical radiologists, as deep learning may influence their training in the close future.

Convolutional neural network is a mathematical concept that is usually collected of three categories of layers. The convolution and pooling layers, implement feature abstraction, while the third, an entirely associated layer, maps the extracted structures into finishing output, like classification. A convolution layer shows a vital part in convolutional neural networks, which is collected of a stack of mathematical procedures, such as convolution, a focused type of linear procedure. In digital images, pixel values are kept in a two-dimensional grid, i.e., an array of numbers (Fig. 3), and a minor grid of parameters called kernel, an optimizable feature extractor, is applied at for each image point, which creates CNNs extremely well-organized for image processing, since a feature might occur anyplace in the image. As one layer nourishes its output into the subsequent layer, extracted features can hierarchically and progressively develop more complex. The process of enhancing parameters such as kernels is called training, which is completed so as to diminish the modification between outputs and ground truth labels through an optimization algorithm called backpropagation and gradient descent, among others.

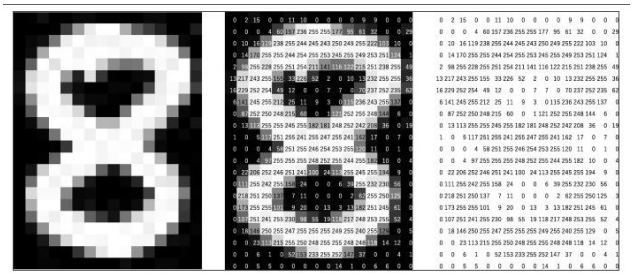

FIGURE 3:IMAGE AS AN ARRAY OF NUMBERS

Training a system is a procedure of discovery kernels in convolution layers and weights in entirely connected layers which reduce alterations between output estimates and specified ground truth labels on a training dataset. Backpropagation algorithm is the technique frequently used for training neural networks where loss function and gradient descent optimization algorithm perform vital roles. A model performance under specific kernels and weights is considered by a loss function through advancing propagation on a training dataset, and learnable parameters, specifically kernels and weights, are modernized according to the loss assessment through an optimization algorithm called backpropagation and gradient descent(FIG4).

FIGURE 4: CONVOLUTIONAL NEURAL NETWORKS ARCHITECTURE

A. ADVANTAGES OF CNN IN MEDICAL IMAGING

• The multi-stream design of convolutional neural networks can accommodate numerous resources of information or illustrations of the idea in the method of channels offered to the input layer. Since segmentation is the best collective mission in medical image analysis, CNNs can be applied to "each pixel in an image, by means of a patch or sub image, centred on that pixel or voxel, and calculating if the pixel fit in to the object of interest" [14].

• Pre-trained on natural images, illustrate decent outcomes, occasionally even stimulating the exactness of trained physicians in approximate tasks. Researchers have gone a step ahead to show that CNNs can be adjusted to influence intrinsic organization of medical images.

IV. DEEP LEARNING IN MEDICAL IMAGING

Various image diagnosis tasks involves preliminary search to recognize deformities, enumerate capacity and varies over time. Automated image analysis tool depend on machine learning algorithms are the key enablers to advance the excellence of image diagnosis and explanation by assisting through well-organized recognition of finding. Deep learning is solitary broadly applied method that offers position of the astern accuracy. It releases innovative entry in medical image analysis that has not been prior. Utilities of deep learning in healthcare envelop a broad series of inconvenience ranging from cancer screening and disease monitoring to custom-made treatment plan. An assortment of resource of information today - radiological imaging (X-Ray, CT and MRI scans), pathology imaging and recently, genomic progression have brought an enormous quantity of data at the doctor disposal. However, we are still diminutive of equipment to translate all this data to helpful information [10].

A. BREAST CANCER AND SCREENING MAMMOGRAPHY DETECTION

The quick progression of machine learning and particularly deep learning endures to fuel the medical imaging group's curiosity in applying these procedures to advance the exactness of cancer screening. Breast cancer is the second foremost reason of cancer deaths amongst U.S. women [11] and screening mammography has been establishing to decrease mortality [12]. Recognition of subclinical breast cancer on airing mammography is thought-provoking as an image classification mission because the tumors themselves reside in only a minor portion of the image of the complete breast. It is vital to influence both the few fully marked up datasets, as well as larger datasets categorized with only the cancer status of each image to advance the precision of breast cancer classification algorithms. Pre-training is a capable method to address the difficulties of training a classifier when the ideal huge and entire training datasets are not available. The pipeline essential to construct a complete image classifier is offered here, as well as the advantages and disadvantages of altered training strategies. To accomplish grouping or segmentation on huge complex images, a mutual strategy includes the usage of a classifier in sliding window technique to identify local patches on an image to produce a grid of probabilistic outputs. Transforming a patch classifier to an end-to-end trainable entire image classifier using an all convolutional design. The function was initially trained on patches and then advanced on whole images. We evaluated whether eliminating the heat map enhanced information flow from the bottom layers of the patch classifier to the topmost convolutional layers in the entire image classifier.

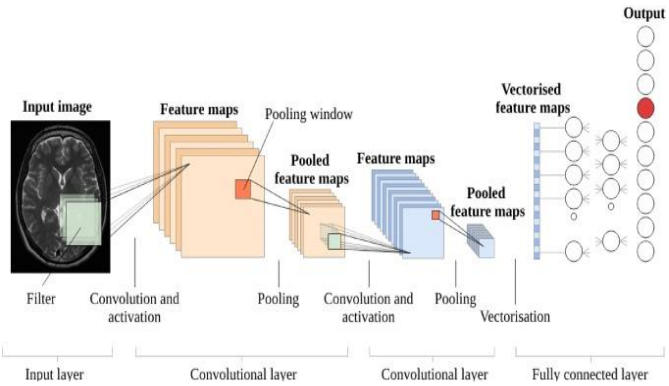

FIGURE5: CNN IN IMAGE SCREENING

To envision the interior breast structures, low dose x ray of breast is taken is known as mammography in medical expressions. It is unique best appropriate methods to identify breast cancer. Mammograms uncover the breast to ample minor doses of radiation associated with devices used in the past [15]. In modern years, it has demonstrated to be one of the best consistent tools for screening and a significant method for the early discovery of breast cancer [16,17]. The mammograms are acquired at two different views for each breast: craniocaudal (CC) view and mediolateral oblique (MLO) view (Figure 6).

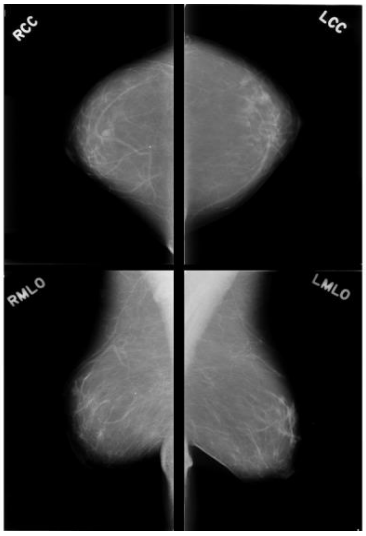

FIGURE 6: Patient Multiview breast mammogram. The primary column presents two views of the right breast: right craniocaudal (RCC) view and right mediolateral oblique (RMLO) view. The second row specifies left breast: left craniocaudal (LCC) view and left mediolateral oblique (LMLO) view.

Deep Learning algorithms have revealed important enhancements in breast cancer detection and classification difficulties over the past decade. The deep contextual and texture structures permit the classifiers to differentiate between normal and abnormal lesions with changing shapes, size, and orientations. This not only upgraded the diagnostic abilities of CAD system but also delivered robust keys for medical practices.

Wu et al [18] presented a Deep learning method to discuss the class disparity and partial data matters for breast cancer classification. The method used the infilling approach to produce synthetic mammogram patches using cGAN network. In the primary step, the multiscale generator was accomplished to make synthetic patches in the objective image using GAN. The generator used a cascading refinement to make the multiscale features to confirm stability at great resolution. Figure 7 demonstrations the synthetic images produced by cGAN. The cGAN was limited to infill only lesion either mass or calcifications. The feature of produced images was experimentally estimated by training a ResNet-50 classifier. The classification enactment of cGAN augmented, and traditional augmentation methods were also equated. The outcomes showed that synthetic augmentation improves classification.

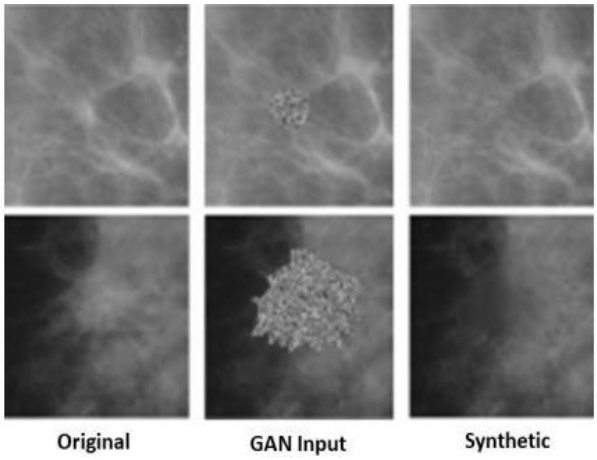

FIGURE 7: Example outcomes from the study by Wu et al for synthetic generation of data by means of conditional generative adversarial network. GAN: generative adversarial network.

V. CONCLUSION

In this paper, we aimed to address the deep learning is used in medical imaging and convolutional neural networks are useful for medical image analysis, performing as well as fully trained CNN's and even outperforming the latter when limited training data are available. Convolutional neural network is important to leverage its prospective to advance radiologist performance and, eventually, patient care. Machine learning (ML) and deep learning (DL) algorithm implemented with convolutional neural network plays an important role in medical image analysis. In this paper, improvement breast cancer with screening mammography detection by the aid of deep learning is described and illuminated.

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