A Study on Content Based Image Retrieval Systems and Deep Learning

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Abstract --- *Content Based Image Retrieval system uses features of query image with that of an existing database image set for retrieval using precision and recall ratio. Features of images include color, shape, texture, etc. Techniques for retrieval include histogram, wavelength transformation, statistical methods, Euclidean distance, etc. The case histories thus generated allow for improvement of patient condition by identifying rare disorders. Deep Convolutional Neural Networks (DCNN), is a machine learning technique, had been used for CBIR general photographic images. Nowadays deep learning is rapidly becoming the state of the art, leading to enhanced performance in various medical applications. Retrieval of medical images using deep learning as a class for content based image retrieval is a task that researchers are faced as a challenge to resolve. In this article, a study ismade where we discuss on the various methods adopted for medical image retrieval using CBIR and DCNN. Today's research advances are made using machine learning, especially with respect to deep learning, for helping to identify, classify, and quantify patterns in medical images too. This deep learning is rapidly becoming the state of the art, leading to enhanced performance in various medical applications. such as image detection and segmentation of anatomical and cellular structures, tissue segmentation, computer-aided disease diagnosis and prognosis[1]*

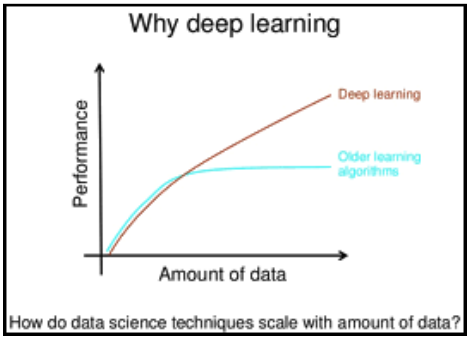
Keywords - Artificial Neural Network, content based image retrieval, deep convolutional neural networks, machine learning, medical images, supervised learning, unsupervised learning

1. INTRODUCTION

An introduction to deep learning defines it as part of a broader family of machine learning methods based on artificial neural networks. Learning can be supervised, semi-supervised or unsupervised.Medical field is becoming more intensive area of research wherein voluminous and complexity images are available in the data generated over the years with genomics contributing rich data set for research(deep learning). Retrieval of images contribute to knowledge base of categorizing patient's disease.

Deep learning is also known as Deep Neural Learning(DNL) or Deep Neural Network(DNN) is part of a broader family of machine learning methods based on artificial neural networks. Learning can be supervised, semi-supervised or unsupervised. The key difference between deep learning versus machine learning stems from the way data is presented to the system. Machine learning algorithms require structured data, wherein deep learning networks rely on layers of the ANN (artificial neural networks).

Deep Learning (DL) methods are a set of algorithms in Machine Learning (ML), which provides an effective way to analysis medical images automatically for diagnosis/assessment of a disease. DL enables higher level of abstraction and provides better prediction from datasets in comparison to any conventional framework that is adopted for image retrieval. Hence, DL has a great impact and is popular in recent years for research.

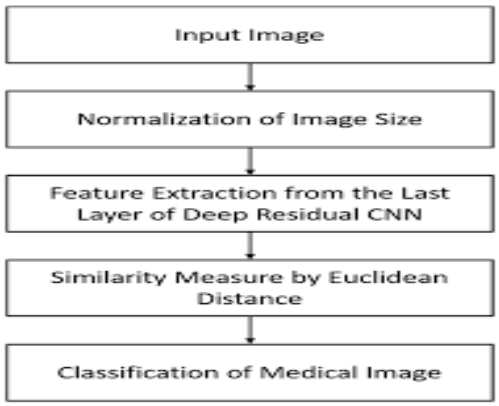


Biological analysis and medicine are disciplines that are rich in data. These data are complex and often ill-understood. Deep learning hence describes a class of machine learning algorithms that are capable of combining raw inputs into layers of intermediate features. Deep learning algorithms have recently shown impressive and high accuracy results across a variety of domains thus making these deep learning techniques well suited to solve problems of these fields. A variety of applications of deep learning in biomedical problems - biological processes and treatment of patients are carried out in order to find out whether deep learning can be able to transform these tasks or if the biomedical sphere poses unique challenges.

Computerized methods decide the optimal decision boundaries in a high-dimensional feature space. Crucial step that is used to develop such a computerized system is feature extraction, which is still done by manually, from images. Machine learning allows computers to learn extracted feature representing the data that is used by many deep learning algorithms that models high level features. Deep learning uses layered non-linearity in its learning system, which uses less features and increases efficiency. (Bengio 2016)

2. TYPICAL ARCHITECTURE OF CBIR SYSTEMS

Classification is defined as a systematic arrangement in groups and categories based on the features of the image. Image classification came into existence for decreasing the gap between the computer vision and human vision by training the computer with the data. The image classification is achieved by differentiating the image into the prescribed category based on the content of the vision.



In deep learning, the neural networks that identify the image based on its features are considered. This is accomplished for the building of a complete feature extraction model which is capable of solving the difficulties faced due to the conventional methods. The extractor of the integrated model should be

able to learn extracting the differentiating features from the training set of images accurately. Many methods like GIST, histogram of gradient oriented and Local Binary Patterns, SIFT are used to classify the feature descriptors from the image[4].

In deep neural networks every node decides its basic inputs by itself and sends it to the next tier on behalf of the previous tier. Neural networks are expressed in terms of number of layers involved for producing the inputs and outputs and the depth of the neural network. Neural networks are involved in many principles like fuzzy logic, genetic algorithms and Bayesian methods. These layers are generally referred to as hidden layers. They are expressed in terms of number of hidden nodes and number of inputs and outputs every node consists.

The convolutional neural network (CNN) is a class of deep learning neural networks. CNNs represent a huge breakthrough in image recognition. CNN is commonly used to analyze visual imagery and are frequently working behind the scenes in image classification.The Convolutional Neural Network (ConvNet) is most popular algorithm used for implementing the deep learning technique. The ConvNet consists of Feature detection layers and classification. A ConvNet is composed of several layers, and they are convolutional layers, maxpooling or average-pooling layers, and fully-connected layers.

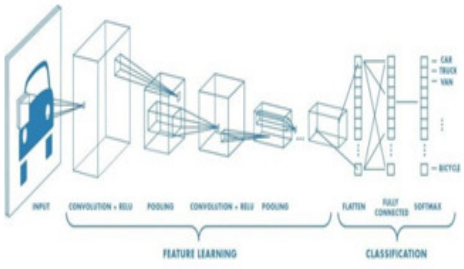


Fig. Convolutional Neural Network (CNN)

3. DCNN FOR CBIR

Mostsamples with expert validation contain only 100–300 patients. The datasets samples are quite small even for simple machine learning algorithms. Deep learning models has many parameters and this pose a greater challenge. Although unsupervised and semi-supervised approaches can help with small sample sizes, the field would benefit greatly from large collections of anonymized records in which a substantial number of records have undergone expert review. This challenge is not unique to EHR-based studies. Work on medical images data in applications for which detailed metadata are required together with other applications for which labels are costly to obtain will be hampered as long as abundant curated data are unavailable. There isa cultural challenge. Beyond the cultural hurdles around data sharing, there are also technological and legal hurdles related to sharing individual health records or deep models built from such records.

There is a lack of standardization of images and classifications that also makes it challenging for investigators skilled in deep learning to enter the field, as numerous data processing steps must be performed before algorithms are applied.

Even if data were perfectly consistent and compatible across systems, attempts to share and combine EHR data face considerable legal and ethical barriers. Privacy of patients severely restrict the sharing

and use of EHR data. The standards are heterogeneous and evolving, but often EHR data cannot be exported or even accessed directly for research purposes without appropriate consent.

The study of cellular structure and core biological processes—transcription, translation, signaling, metabolism, etc.—in humans and model organisms will greatly impact our understanding of human disease over the long horizon. Rapid progress is made in genomics and imaging fields where important tasks are readily adapted to well-established deep learning paradigms. Many researchers have applied unsupervised deep learning models to extract meaningful representations of gene modules or sample clusters.[2]

4. APPLICATION AREAS

A major breakthrough is been done in retrieval of medical images using machine learning research. This is done using deep learning that has uses machine learning algorithms for modelling the medical data. Deep learning mimics the human brain. The deep architecture and information in human brain is processed through multiple layers of transformation. So to learn features from data automatically at multiple level of abstractions by exploring deep architectures, deep learning techniques gives a direct way to get feature representations by allowing the system (deep network) to learn complex features from raw images without using hand crafted features. Recent studies have reported that deep learning methods have been successfully applied to many applications areas e.g., image and video classification, visual tracking, speech recognition and natural language processing.

Deep learning in medical image analysis have been applied with different images for different purposes. For instance, analysis of brain images with DL techniques have been performed for disorder classification, lesion/tumour segmentation, lesion/tumour detectionand also for enhancement or construction of brain images.A breast image analysis using deep learning is mostly performed for detection of lesions or mass-like structures and grading of breast cancer risk. DL techniques have been applied to for segmentation of ventricles or cardiac structures from MR, CT or US cardiac images. Most of them use CNN architectures.

Segmentation of liver, kidney, pancreas and bladder with DL based methods has been usually applied with CT images and CNNs. Applications of Deep Learninginclude image recognition, natural language processing, portfolio management and prediction of stock price movements, drug discovery and better diagnosis of diseases in health care, speech recognition, robotics and self-driving cars.

5. CONCLUSION

Critical analysis and observation using deep learning based techniques states that DL are used effectively in medical image analysis especially in recent years. CNNs are successful models for image analysis. Therefore, mostly, CNN architectures have been preferred and integrated into other techniques such as, SVM and level sets. Literaturereview shows that deep learning has yet to revolutionize biomedicine or definitively resolve any of the most pressing challenges in the field, but promising advances have been made on the prior state of the art. Even though improvements over previous baselines have been modest in general, the recent progress indicates that deep learning methods will provide valuable means for speeding up or aiding human investigation. It is also observed that images if classified correctly even for test images; deep learning algorithm will prove to be very effective. It is expected that DL will become more popular for analysis of medical images and have great impact in this research area.

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