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A Review on Impact of Deep Learning and TensorFlow in Medical Image Processing

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***Abstract*—Exponential raise in data and images leads to evolution of Artificial Intelligence. Deep learning is a domain of Machine Learning and a unique form of Artificial Neural Networks from AI. These peculiar features facilitated to apply Deep Learning technique on Medical images. These applications acquire deep insights from the image processing. Diagnosing, tumor detection, predictive modeling on electronic health records, classification on clinical heart failures and Blood flow Quantification and visualization are some of the real time applications in health care industry for image processing. Bio-medical images have numerous parameters and variations with respect to dimensions and channels. Hence the images require deep analysis to detect subtle dissimilarities. De-noising, spatial normalization, bias-field correction and nature of acquisition are some of the challenges while handling image datasets. These challenges are addressed by applying TensorFlow framework using deep learning methods. In this paper a review on image processing using deep learning is discussed in order to improve the efficiency of the models by adapting tensor flow framework.**

***Index Terms*— Artificial Intelligence, Deep Learning, Artificial Neural Networks, Tensor Flow, Machine Learning, Medical Image Processing.**

I. INTRODUCTION

Machine learning (ML) consist groups of learning algorithms which use supervised or unsupervised techniques to analysis data and extract computations for future predictions. These algorithms perform various functions such as analyse, forecast, decision making, realizing hidden structures and discovering patterns. The learning process of ML is an automatic process which is a part of Artificial Intelligence.

The process of analyzing the data is categorized into three major types. Identifying patterns, recognizing symbols and differentiating images is the initial approach and is referred as Symbolism. Network analysis, connections and neural nets forms under second category and is referred as Connectionism. Finally this approach uses probability and conditional probability which is referred as Bayesian. These approaches are implemented automatically using machines where human intervention is minimal.

The machine made experienced with many number of training examples using a model later it is given a test set to analyse or extract from the new data. As the complexity is increasing in the new datasets the existing approaches are not sufficient to respond for query intricacies. These data require a deep analysis and super computational skills in order to extract knowledge from data. When the dataset consists of images, complexity increases in processing from different variations.

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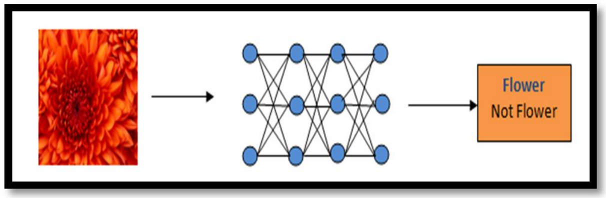
A. Deep Learning

To handle these image datasets a deep analysis is necessary which is provided by Deep Learning methods. By considering, the medical images have many variations, dissimilarities and structural abnormalities. Deep learning techniques reveal remarkable performance in mimicking humans in medical image processing. Many limitations of CAD systems are overcome by Deep Learning methods.

Today's computers technology can classify pictures inspecting elements using deep learning mechanism. Imagenet is the massive database of labeled images to train convolutional neural network using Graphic Processing Units accelerated on frameworks such as Pytorch, Tensorflow, PaddlePaddle, MXNet and Toolkit as well inference optimizer named TensorRT.



Input Feature Extraction + Classification Output

Figure 1. Process of Deep Learning methodology

The figure 1 describes the process of deep learning techniques by extracting the features from hidden layers. This consists of three process Input, Feature extraction + Classification and output.

B. Features of Deep Learning

The images have voxel dimensions depicting physical spaces compute scaling on the images by transforming the images in to vector spaces. For conducting these processes following features are exercised:

- Data I/O considerations: Size of the dataset impacts on the speed and processing while training the images.
- Data Normalization: Removing the variations in the data depend upon imaging modality and acquisition parameters
- Data Augmentation: Adding noise to training images generalize and adding random offset to handle difference between images
- Class Balancing: An imbalance class largely affects phenomena and accuracy while training.

C. TensorFlow

Tensorflow is an open source framework developed by Google used for variety of heterogeneous systems that range from mobiles to super computers. The reason for using this technology is the setup that allows for seamless utilization of the computer's processor and graphics card, resulting in much faster converging than when trained only with a processor.

The network topography constituted of an input layer with 163 input neurons, two hidden layers with 80 hidden neurons in each and an output layer with a single output neuron. For neurons in the hidden layers the activation function was what is known as a rectifier or ramp function for performance reasons [1].

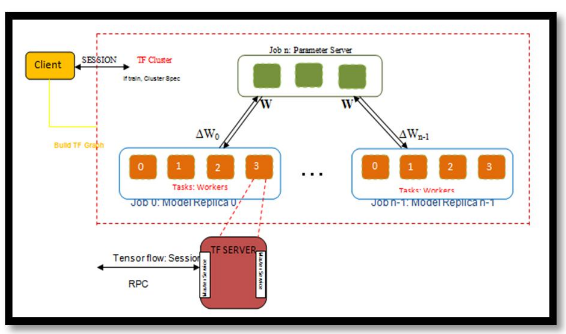


Figure 2. Tensor flow image processing Source: [3]

The NVIDIA GPUs have been integrated with Google Cloud Machine Learning and TensorFlow to help reduce the time taken to train machine learning models at scale. Native support for the Caffe, Theano, and TensorFlow frameworks and 15 open sources deep learning models run as microservices. GPUs on-demand and running in the cloud eliminate the manual work required for teams and organizations to set up and experiment with cutting-edge deep learning algorithms and models, which allows them to get started for a fraction of the cost [2]. Figure 2 describes the process flow between TF server and Task workers. Client process the jobs in TF Cluster which are analyzed by the model replicas by interacting with RPC at Tensor flow Session.

This paper is organized in to 3 sections. In the second section it discusses the applications of deep learning in medical image processing. Section 3 describes the use of Tensor flow in handling medical images and its use improves the performance in terms of speed and accuracy. Finally section 4 concludes.

II. Applications of Deep Learing in Image Processing

Deep learning uses back propagation algorithms in identifying complex structures by revising the parameters after every iteration. Neural network is applied by increasing the number of nodes and constructing a deep graph with multiple processing layers. Convnet architecture is the prominent deep learning method this classifies and recognizes the images with more accuracy. In 1998 this method was used for identifying the hand written digits and is introduced by LeCun having 70% of remarkable accuracy [4].

The optimization algorithms are applied on images for deep analysis and revealing the hidden patterns from the images. These algorithms use GPUs in order to generalize demand of large datasets. Particularly limited number of images does not serve the purpose while applying deep learning mechanism. More number of images will increase the accuracy and drawing of insights.

Convnet architecture excel by training with many more examples. Since the image datasets in peculiar fields are usually small, due to this extracting the dominant features lack the data [19]. More complex images require massive dataset for successful classification due to the following reasons:

- Image object size varies in scale because of many dimensions
- Multiple objects in a single image should be analysed
- Distracting object in the images should be removed

Some of the biological patterns recognised from medical images using deep learning are listed as below:

- Wang and contemporaries were able to perceive mitoses in breast cancer histopathology images by using manually tunned cellular morphology and Convnet features [9].
- Arevalo introduced interpretable layer referred as digital staining to classify basal cell carcinoma using deep learning approach reframing the existing strategy [10].
- Deep learning was already successfully applied to detect cancer in biopsies, diabetic retinopathy and dermatologic lesions. Some studies using Convnet are applied on cardiac tissues to detect clinical heart failures [6, 8].
- Predictive modeling with electronic health records data is anticipated to drive personalized medication for improving the quality and detecting the diseases priorly by statistical deep learning methods [12, 13].
- Observational medical outcomes defined by Observational health data science and information consortium allows consistent development of predictive models to extract normalize data from different sites [15].
- Unharmonized data is represented using clinical data structures in an extensible container format for maintain consistency and simplifying data interchange between sites [7].
- Each ICU patients has significant data with various parameters. These parameters are observed under certain periodic conditions for treating the patients in an appropriate way by using deep learning [16].
- A predictive model is depicted on impatient mortality using AUROC and logistic regression in order to observe the time period of mortality after admission [11].
- Electronic health records are observed to recommend the patient for readmission or long stay in hospital in order to reduce the mortality by constructing predictive model [5] [14].
- Many images have some features of both normal and abnormal myocardium such as large regions of healthy, densely packed myocytes or fibrosis and enlarged nuclei are detected using deep learning [18].

- Normal cardiac tissue shows regular, dense arrays of cardiomyocytes with stroma limited to perivascular regions. Patients with heart failure have an expansion of the cellular and acellular stroma tissue that disrupts cardio myocyte arrays [17].
- Recognizing the tumor using features such as albumin, blood urea nitrogen, pulse and white blood cell using time aware neural network models trained on separate modalities to handle redundant features [9].

III. TENSOR FLOW IN HANDLING IMAGES

Medical images have major dimensions in regards to time and channels of natural photographic images [20]. These images are hand-engineering features using GPU accelerated networks to scale unprecedented amounts of data. DLTK is a toolbox of a Tensorflow framework uses volumetric images and due to spatial dimensions and memory issues. Normalization, bias-field, correction, de-noising, spatial normalization are certain features of Tensorflow in handling medical images.

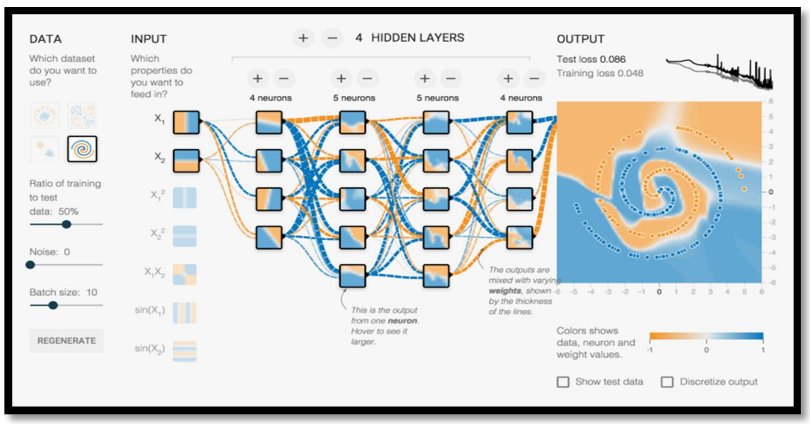


Figure 3: Deep Learning process using TensorFlow

The process of deep learning using TensorFlow is illustrated in figure 3. Huge datasets are given as input in the initial stage partitioned as 50% as train data and 50% as test data. There is no noise in data as it was priorly pre processed. The batch size of the data set is given to be 10. Among many features some selected properties are feed for analysis. The process analyses from various hidden layers built upon multiple properties of the model. The model is trained using neural networks by classifying the data as '+' (positive) or '-'(negative) classes. These class labels are trained and as required the numbers of neurons are increased. Outputs are mixed with varying weights shown as thick lines. The final output is represented as discretize output with a test loss of 0.086 and train loss of 0.048. From the figure 3 displaying hidden layers it is evident about the no of neurons involved in producing the efficient output. Spherical on the right side has 2 colors, light orange represents the negative values whereas blues are positive classes ranging from [-1 1]. Thus it deeply analyse the input data on the tensorflow framework in a sophisticated approach.

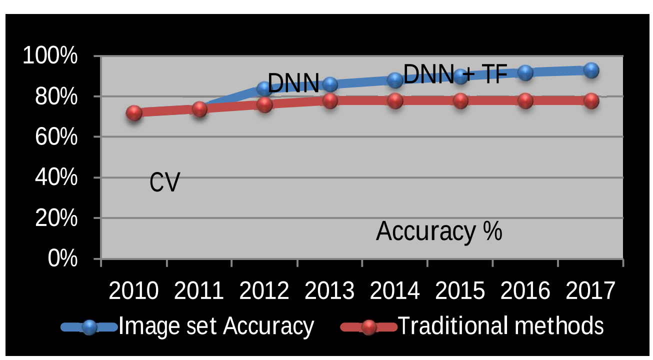


Figure 4: Percentage of Image set Accuracy

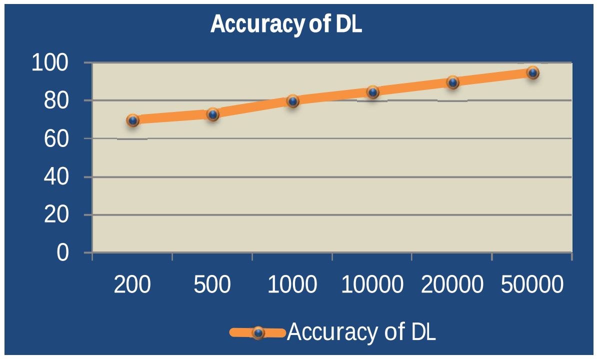


Figure 5: Accuracy on processing the datasets

The graph in the figure 4 represent two lines, one displays traditional methods accuracy which is red and the other line in blue displays the use of Deep Neural Network using TensorFlow with a 95% accuracy from 2010 to 2017. Accurate computations can be made as there is a increase in the size of dataset. In particular deep learning mechanism the size of the dataset purely depends on the number of training examples are feed to the model while training. Precise computation can be extracted only if the number of training examples is more. This is evident from the figure 5 this displays the accuracy of the model as the number of training dataset increases.

Deep learning problems such as handling huge datasets in identifying the hidden patterns are managed by implementing on TensorFlow framework. It facilitates deep learning a toolbox with necessary processing capabilities and accuracies.

IV. Conclusion

Deep Learning has proven to be the most sophisticated and advanced technology for processing image datasets. Deep Learning's efficiency can yielded by large datasets but not by time, cost and requirements. Although with many improvements some limitations of deep learning methodology can be addressed with the prominent framework TensorFlow for better medical image processing. This paper suggests the use of the tensor flow framework for analyzing the deep learning model for medical image processing.

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