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A DEEP LEARNING APPROACH USING CONVOLUTION NEURAL NETWORK TO CLASSIFY PARKISON'S DISEASE

Mohd Naseem Ahmed
Student
Dept of IT
MGIT
Hyderabad, India

Battu Archana
Student
Dept of IT
MGIT
Hyderabad, India

Manga Vikas Goud
Student
Dept of IT
MGIT
Hyderabad, India

Mrs. Nazia Tabassum
Assistant Professor
Dept of IT
MGIT
Hyderabad, India

Abstract: A major role has always been played by Machine Learning Techniques and algorithms in the field of biomedical sciences when it comes to the topic of pattern recognition. Aid is provided by these techniques to researchers for the purpose of classifying medical imagery and for the purpose of predicting models for the possession of a greater and better understanding related to medical problems and their complexities. The subfield that relates to the machine learning techniques that come in contact with the functioning of the brain along with its structure is Deep Learning, also known as ANN or Artificial Neural

Network. Convolution Neural Network or CNN has been used in this paper so as to classify images of the neural brain for the identification or differentiation of the brains of people affected with Parkinson's Disease (PD) and those that are not. Classification of complex clinical data for the detection of Parkinson's Disease or the estimation of the stage of the disease at any moment is a challenging and difficult feat to accomplish. CNN is a Machine Learning Technique that uses MRIS, MRIs, and other such rich data resources to learn from and for the developing of classification with accurate imagery.

The classification of MRI data of Parkinson's Disease patients with those who were healthy was done with an accuracy of 97.63% without normalization and with an accuracy of 97.91% in the batch with normalization by using Convolution Neural Network. This successful event goes to show that CNN is good at the extraction of the foremost discriminative characteristics of the complex clinical data and thus the constant design is capacitated with the ability to effectively be used in this analysis for performing a variety of medical imaging classifications and more.

Keywords: Parkinson Diseases, Machine Learning, Artificial neural network, Convolution neural network.

I. INTRODUCTION

Parkinson's Disease (PD) is a disease that is neurodegenerative in nature. Its name was first called so by James Parkinson. It is found to be caused by the successive loss of dopaminergic neurons in the SNC, also called as the Substantia nigra pars compacta. This disease usually gets worse over a progressive period of time. Due to an exponential growth in the umber cases of this particular disease, there's an economic burden on the Government. No cure for this disease has been found that eradicated the disease yet. Other symptoms of this disease include highly impaired coordination and balance that can lead to falling down of the affected. person too. Depression, skin problems, sleep problems and urinary problems along with constipation also go hand in hand with this particular disease.

Problem Statement:

Concerned with most areas when pertaining to clinical diagnosis, prevention is valued better than re is. Parkinson's Disease affects about 1% of the population that have passed the age of 60 years. Thus, so as to get access better treatment, the diagnosis as early as possible of PD is highly essential. Highly careful medical assessments are required for the early and acute diagnosis of Parkinson's Disease. Magnetic Resonance $Imaging (MRI) helps in the early diagnosis of PD and the PD stage providing neuroanatomic biomarkers. The importance of classifying this type of clinical medical knowledge is the potential development of models that are predictive in nature to provide classification and recognition of PD affected subjects from normal and healthy subjects. Magnetic Resonance Imaging (MRI) and CNN (Convolution Neural Network) are used in this work for the development of the predictive models aforementioned.

LITERATURE REVIEW

For a considerable amount of time now, a lot of analysis has been prevalent within the medical field for clinical datasets cognitive datasets, neuroimaging and biomarker datasets for differences in aging with Parkinson's Disease and with normal aging. Everywhere in the world, the developed and developing countries included, population aging has become more prevalent. With affecting rate being 1% when it comes to people over the age of sixty. neurodegenerative diseases like PD a removing at a very prevalent rate. Classification of all the medical data so as to make a developed predictive model to accurately diagnose PD along with the PD stage and to differentiate between affected patients with those not affected is the significance of this work. Keeping in mind the medical paper titled "Medical Image Classification. with Convolution Neural Network" and previous studies, when working for image classification, achievement of critically good classification is found to be one of the most prominent and primary problems. The criminative power and the descriptive power that the feature vectors of the images contain is found to be the main cause for the problem mentioned above. The feature vectors extracted from this imagery is what is used to train the models for classification purposes. For a period of several years, Artificial Neural Network, to unravel complicated problems dealing with classification of images. Recently, CNN, the Convolution Neural Network, the deep learning technique, has shown results that are above ordinary when it comes to image classification and differentiation. Among the advantages found, one is found out to be that they can be generalized so as to solve a variety of problems but while using the same design.[1]

In the medical paper mentioned above [1] the writer has shown that CNN has a superior performance level in finding critical and crucial issues in image classification and that its performance exceeds that of human level when it comes to application like those of traffic light detection with outstanding progress levels. Owing to less variation rate between different classes and high visual similarity rate within the same class. achieving classification with high level of accuracy has been found to be a challenging feat. In this paper, the architecture of one single convolution layer was used for the reduction of the number of problems with the parameters in CNN so as to avoid the problem being over-fitted.

In the paper titled "Classification of Alzheimer's Discase Using fMRI Data and Deep Learning Convolution Neural Networks", the author talks about feature selection and the challenges it poses along with image classification reduction. Challenges posed with selection of the most discriminating features that are needed for the model for classification are demonstrated in this paper. Some architectures related to Convolution Neural Network, CNN, that have classified and differentiated successfully between subjects affected with Alzheimer's and those that are not have been discussed. [3] A Bayesian Network Decision Model for Supporting the Diagnosis of Dementia, Alzheimer's Disease and Mild Cognitive Impairment", the paper, there is a Bayesian Network Model proposed for diagnosing dementia, Mild Cognitive Impairment (MCI) and Alzheimer's because representation of casualties and uncertainties in medical imaging can be done with these networks.[2]

Another relevant paper concerning Bayesian Network Model titled "Predicting Dementia Development in Parkinson's Disease Using Bayesian Network Classifiers", pats forward the use of filter-based multivariate Naive Bayes Model to differentiate dementia in patients with PD and those with not and claims it as the best classifier as its sensitivity to being cross-validated is the highest.[4] In this paper, there's presented how studies including surrogate, neuroanatomic biomarkers given by MRIs or Magnetic Resonance Ing. by researchers have shown that these help in the early diagnosis of diseases. In this work. Nave Bayes, filter selective Naive Bayes, multivariate filter based Naive Bayes and support vector machines, abo called SVMs, are the four types of classification models whose application has been used for the equation of their capacities to differentiate between patients affected with Parkinson's Disease (PDCT) PDMCT and PDD.[4]

METHOD

30 patients affected with Parkinson's and 24 normal elderly subjects within an age range sixty to seventy-five years had been selected from the Parkinson's Progression Markers Initiate, PPMI dataset had been taken into study for this work. The patients used for the work had been found perfectly healthy and with no previous records of any neurological problems or diseases or conditions, and no medical history of the for mentioned at all. A Siemens Trio 3 Tesla MRI scanner was what the scanning was performed on. A 3D MPRAGE sequence was used to acquire the anatomical scans. Using the Brain Extraction Tool, non-brain tissue was removed from thos1 anatomical pictures.

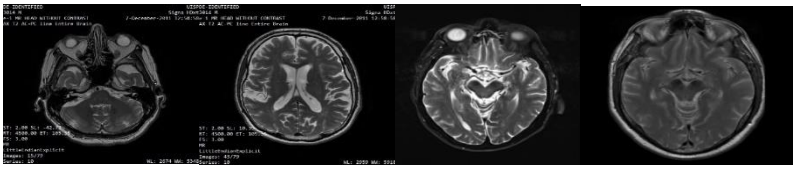

Fig: Training Dataset

TI w MRI Scans:

The 3D pre-processed MRI data was found in both formats, NIFTI and DICOM. in the PPM dataset. Exchanging and transmitting of medical images in a format that is standardized is what DICOM is used for, furthermore, it enables medical imaging devices to be integrated from multiple manufactures. Inter-operation facilitation data analysis software packages of functional MRIs, a free analyse-style data format is NIFTI. The NIFTI format data was gained from the Parkinson's Biorepository and database for this particular study. These pictures were concatenated across t and axes, which were then convert into a 2D image stack where each slice in the PNG format was represented by each 2D image. Visualization tool MRIcro. Python OpenCV(opencv.org) and Neuroimaging Package Nibabel (http://nipy.org/nibabel/) were us for the aforementioned conversions. So as to feed into the Deep Learning platform. Binary classification of Parkinson's Diseases Normal images was labelled next.

For 200 Parkinson's Disease affected patients, a number of 6132 images were obtained and for the 200 healthy test control subjects, a number 4416 images were obtained.

MRIcro Tool:

MRIcro is a tool for image viewing for medical images. Medical images are allowed to be viewed on Linux and Windows computers by this tool. It is a single product that together with tools that function sort of like a software system that permits neuroimager to investigate MRIS, (MRIs and PET images. MRIcro permits viewing and exchanging of brain pictures efficiently Furthermore, it makes spotting regions of interest (ROIs, for example) for neuropsychologists Production of analyse format headers for the purpose of exporting of brain images to various platforms reminiscent of jgp. png and DICOM platforms is also permitted by this.

Converting Medical Images into the Analyze format:

When medical images are converted into Analyze format, a 2D image selection takes foreign to Analyse' option in the import menu will give rise to a brand-new window that will further enable us to describe the images. Each image that was saved had slices that were 256 and these were further on then converted into .png format and into 2Dimages.

DATA VISUALIZATION

The data visualization using Nibabel package which is package developed for Neuroimaging and the complete code visualized in Python.

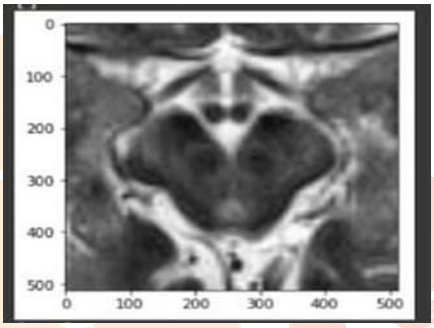

Fig: Data Visualization using Python

DEEP LEARNING

Deep learning a learning technique for machines. It is an Artificial Intelligence function that copies the human brain in the processing of data for usage in detection of objects, speech recognition, language translation and decision making. This function has the ability of learning without the help of supervision from humans. It learns from unlabelled and unstructured data forms. Bringing about an explosion of data found in all forms and from all the regions in the world, deep learning, along with the digital world, had evolved.

This model helps in tige reduction of the dimensions of the collected dan and also in reduction of features. Often, it is used for problems associated with input data analog like pixelated image data, documents with text, video or audio data files.

Convolution Neural Network:

This is an enormously powerful machine learning technique utilized in quite a few programs along with handwritten digit recognition, image classification and visual recognition. It is a unique type of neural network which is multi-layered and which that extracts, with the least amount of pre-processing, visual patterns from images that have been found to be pixelated. filters that are smaller for the simplification of the learning model The CNN networks have a variety of 1 combinations of convolution layers, fully connected layers dense layers, or 1 normalization layers, max pooling layers.

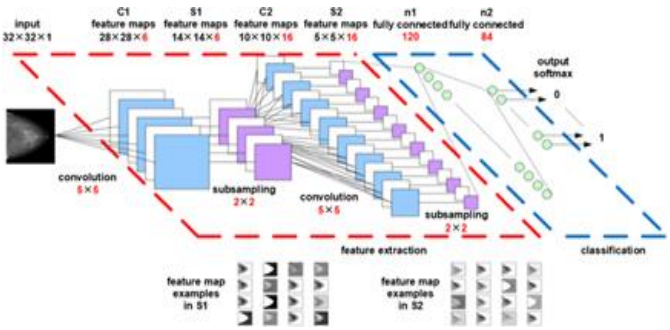

Fig: Architecture of Convolution neural network

Convolution Layer:

Small portions of the input layer are what is treated as the lowest layer in the hierarchical structure in CNN. The convolution layer is the first layer and consists of neurons that Tave biases and learnable weights or are also termed as 6 set of learnable filters. The most important core building block in this of this network is the CONV layer, with which feature maps are created using input images. A filter is a group of values, known as weights, that detect specific features after being trained to do so. Every filter is small in length, additionally known as window length or kernel length. However, it spans throughout the total volume of the input. This layer functions to compute a dot product within the weights of the units or the neurons and the patch or local region of the volume of the input that they are linked to.

Max Pooling Layer:

A pooling layer is inserted usually into among consecutive CONV layers. The pooling layers on action is to lessen or the reduction of the down sample for the spatial length of this very representation. This is achieved so as to lessen the bigger quantity of the parameters that are hyper in this network and for the controlling of overfitting or of overlapping. On each depth slice, the Pooling layer operates individually and by the usage of the MAT pooling operation, spatially resizes it. A Max pooling function will partition the input data that is gained from the immediately previous CONV layer, and will convert it into a set of windows that overlap and for each sub-region or area, returns the maximum value. neurons that make contributions to pooling output.

Normalization Layer:

The layer inside a sequence of CONV and MAX pooling layers is called as the Activation Layer or the Normalization Layer. This layer is used on the input for function and feature scaling and for hidden layers in batch normalization. This layer scales the input in order that the output has close to no standard and mean deviation for the purpose of efficient training. An elementwise activation features along with max (0.x) thresholding at zero. All the precise weights belonging to the neurons increased via way of means of the input and the entire of them is then simulated via the activation feature to test if it is more than the threshold or less than. If it is more, then it returns to zero.

ReLU-Activation Feature:

A rectified linear unit that is simple and easy characteristic for producing desirable Experimentation results is ReLU. It can easily be described within following graph, the for negative values.

Flatten:

The layer found after consecutive pooling layers and convolution is Flatten. Convolution layers output activation maps that are three dimensional in nature such that typically, the output is wanted so as to locate and pick out if an image belongs to a particular class. This layer converts the three-dimensional features to one dimensional feature vectors.

Dense Layer or Fully Connected Layer:

Fully Connected Layer is CNN Network's final layer. By a learnable weight, every output here is connected to every input in this typical neural network. A CNN chain's network of computation will lead to a related network that takes facts and information and will further integrate them all throughout the locations in the functions and characteristics of at map layers present below. In this layer, each unit or each neuron has a connection to all the neurons present in the previous volume. Also referred to as the Dense Layer, here, by use of weight, each output has a connection to each input, which is then further followed by an activation function which is non-linear in nature.

Drop Out Algorithm:

The drop-out algorithm is random disabling of neurons in the CNN network. To improve the model, this is applied while the model is being trained. With the equal length or size of neurons in a layer, a drop out map is carried out. This is accomplished so as to mark the corresponding neuron's on and off stage at each training iteration's beginning. All the neurons are in the on stage while testing is taking place but the activation signal is attenuated to the opportunity of average turn out rate.

Implementation:

Below are the packages used in Python:

- Pylab
- Keras
- Nilabel, Nilcam, CV2
- Matplotlib
- NumPy. OS.

After changing the PD affected patients' and non-affected control subjects' images to the png layout from the NIFTI layout, to study the image files, a Tensorflow background in python had been used. The control subjects ‘neural images were labelled with '1' and the PD test subjects' neural images were labelled with '0'. For a total of 54 patients, 10,548 slices of images had been collected. This whole dataset of slices was divided into1055 images containing 10% test data and 93 images containing 90% training data. For validation during the training phase or the learning phase of the model, 20% of training dataset was used

One Hot Encoding:

Class vectors (or categorical variables are converted into binary class matrix so as to provide it to machine learning algorithms to work better in prediction. This process is called One Hot Encoding. From the Keras package, the function.

epochs were 30 and the selected batch size was thirty-two or sixty-four. The epoch loss and accuracy are plotted.

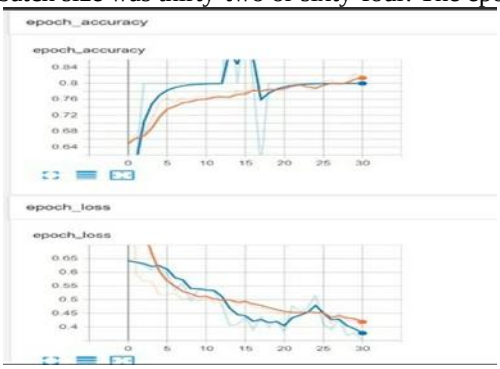

Fig: epoch accuracy and loss curve

RESULTS:

In the Baseline Model's training phase, the validation records and data along with the accuracy of the training had been measured. The models were then tested using the dataset for the test. The comparisons for the gained training accuracy after the thirtieth epoch was found to be 96.65% and the accuracy for test for this model was 97.63%. 0.07% was the loss that was attained. The model loss and model accuracy plots are given.

The loss function has been used to measure the accuracy of the network in identification of Parkinson's Disease in the given image inputs. The plot of the model loss has been given.

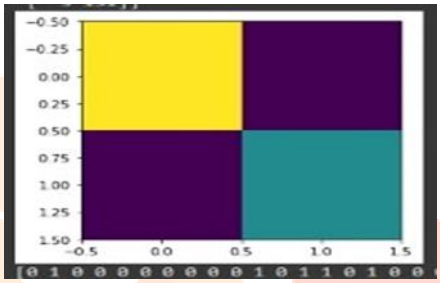

Fig.Test Accuracy of image -classification models.

The gained training accuracy after the thirtieth epoch was found out to be 95.43% and accuracy for the test for this model was found to be 97.91%. The attained loss was 0.05%. The model loss and model accuracy plots are given. Performance of the Model with Batch Normalization: • Accuracy in training-96.59%

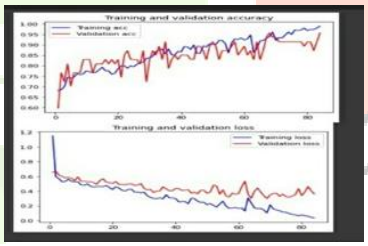

Fig: Batch Normalization Model Accuracy of Train and Validation Set

- Accuracy in test-49.6%
- Confusion Matrix

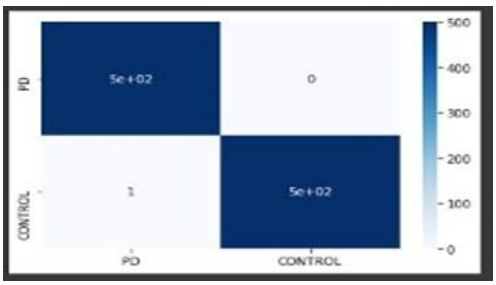

Fig: No Batch Normalization Model Confusion matrix

CONCLUSION

In this work, the efficient classification of the Parkinson's Disease reports, records and data from the normal and those that were found to be healthy control subjects with an efficiency of 97.91% accuracy by the usage the Convoluted Neural Network, also called the CNN. Deep Learning architecture with drop out algorithm and with batch normalization. A large number of images were used to train this model. This version turned into being able to predict the PD for different stages and different ages of people and is efficient for learning of the differences in between on-PD related neurologically degenerative problems related to dementia and cognitive decline. Convoluted Neural Network models with parameters that have been optimize have been applied. Lastly, the two best % and 97.91% respectively. Optimization of the built model so as of overfitting kernel size units or neurons by using the drop out algorithm.

For the conclusion, this work was found to be very resourced and motivating. Yet, there exists a huge area of study that is untouched concerned with the development and innovation of architectures that can be leveraged and used for the detection of Parkinson's Disease.

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