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Detection Of Alzheimer's Using Neural Network Models – CNN And VGG19

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***Abstract*— The count of people suffering from Alzheimer's has been gradually increasing over time. The disease is a bane to mankind and is also becoming one of major cause of deaths in recent years. A man with Alzheimer's looses his cognitive ability over time and it makes his life difficult. To prevent this disease, it is important to detect in its early stage. There are many different approaches taken to diagnose this disease one such is through MRI scan images of brain. In this paper the approach of detection is through the same technique. Brain scan images are used as input to train neural network models like CNN and one of its advanced architectures VGG19. The performance metrics of each model is evaluated and the accuracy is presented as the result.**

Keywords*— Alzheimer's disease, CNN, VGG19, Neural Network, Classification, Accuracy.

I. INTRODUCTION

The disease Alzheimer's is proven to be one of the complicated conditions to deal with as it snatches away one's intelligence and cognitive abilities. Memory impairment can be a biggest setback for any human being. Also, this disease doesn't seem like a mere illness that affects only people of certain age but every one either young or old and this fact of age seems like a biggest risk factor. Even the ones of age 40's or 50's are suffering from this illness which leave the medical field baffled.

The reason for this disease can be derived genetics or also some developed condition over period. There are different stages of Alzheimer's that is 1.) Mild 2.) Moderate 3.) Severe.
The condition of a patient over the stage develops to become worse and he/she tends to loose her memory at stage and is unable to recognize one's own friends or family[1]. The condition at severe stages is irreversible. There are many techniques used in medical field for diagnosing the condition in its early stages.

As technology is seeing many advances there are new imaging tools that are developed and are used in diagnosis of Alzheimer's disease. So Magnetic Resonance Imaging in one such technique. Coming to the development in the field of Machine learning and Artificial intelligence there are been many applications regarding classification, prediction and detection. There are many similar sets of works seen i.e., regarding detection of Alzheimer's using these technologies in recent times as well.

We here in the proposed work are using MRI images of patients to detect the condition by using some advanced Artificial Intelligence Models [10][11]. The data set used here contains brain scan images of people and is classified into 4 stages – non-demented, mild, very mild and moderate. For this study data fetched is from Kaggle a trusted online opensource website. The modelling part of the work extensively uses Python 3.8 along with two major libraries TensorFlow and Keras. The data is fit into basic CNN and VGG19 models to observe their performance and also understand which model is performing better.

II. MODELLING AND IMPLEMENTATION

A. CNN

Convolution Neural Networks are one such DNN models that are having exceptional learning abilities and the reason for this is utilization of N number of stages for feature extraction and their ability to learn automatically [3][4]. This one of the techniques that is mostly used when it comes to any application of classification or computer vision.

Basic CNN consists of a pooling layer, a fully connected layer and convolution layers. Some regularity units like dropout and batch normalization are also incorporated to maximize the model's performance. The structure of a basic CNN model can be seen in figure1 shown below.

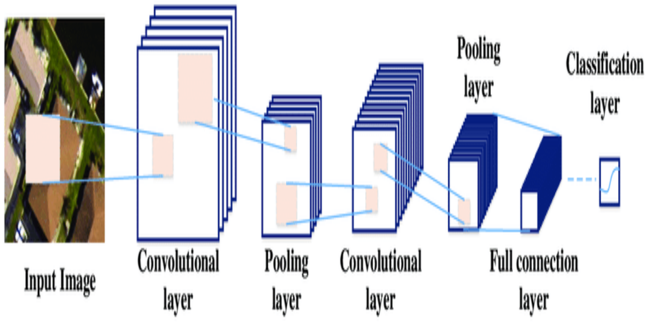

Figure 1. CNN Architecture

Basic CNN model uses sequential() function rom TensorFlow keras library and the definition of layers are done accordingly as shown in summary of model in figure2 .

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 174, 206, 16)	448
conv2d_1 (Conv2D)	(None, 172, 204, 16)	2320
max_pooling2d (MaxPooling2D)	(None, 86, 102, 16)	0
separable_conv2d (SeparableC	(None, 86, 102, 32)	688
separable_conv2d_1 (Separabl	(None, 86, 102, 32)	1344
batch_normalization (BatchNo	(None, 86, 102, 32)	128
max_pooling2d_1 (MaxPooling2	(None, 43, 51, 32)	0
separable_conv2d_2 (Separabl	(None, 43, 51, 64)	2400
separable_conv2d_3 (Separabl	(None, 43, 51, 64)	4736
batch_normalization_1 (Batch	(None, 43, 51, 64)	256
max_pooling2d_2 (MaxPooling2	(None, 21, 25, 64)	0
separable_conv2d_4 (Separabl	(None, 21, 25, 128)	8896
separable_conv2d_5 (Separabl	(None, 21, 25, 128)	17664
batch_normalization_2 (Batch	(None, 21, 25, 128)	512
max_pooling2d_3 (MaxPooling2	(None, 10, 12, 128)	0
dropout (Dropout)	(None, 10, 12, 128)	0
separable_conv2d_6 (Separabl	(None, 10, 12, 256)	34176
separable_conv2d_7 (Separabl	(None, 10, 12, 256)	68096
batch_normalization_3 (Batch	(None, 10, 12, 256)	1024
max_pooling2d_4 (MaxPooling2	(None, 5, 6, 256)	0
dropout_1 (Dropout)	(None, 5, 6, 256)	0
flatten (Flatten)	(None, 7680)	0
dense (Dense)	(None, 512)	3932672
batch_normalization_4 (Batch	(None, 512)	2048
dropout_2 (Dropout)	(None, 512)	0
dense_1 (Dense)	(None, 128)	65664
batch_normalization_5 (Batch	(None, 128)	512
dropout_3 (Dropout)	(None, 128)	0
dense_2 (Dense)	(None, 64)	8256
batch_normalization_6 (Batch	(None, 64)	256
dropout_4 (Dropout)	(None, 64)	0
dense_3 (Dense)	(None, 4)	260

Total params: 4,152,356
Trainable params: 4,149,988
Non-trainable params: 2,368

Figure 2: CNN Model Summary

B. VGG19

VGG model basically follows the Convolution Neural Network Architecture (CNN) and is developed by Simonyan. When compared with ZfNet and AlexNet, VGG19 is 19 layers deeper. This structure is a successor if CNN architecture that was built ti increase the performance[5][6]. VGG is mostly known for its simplicity and commonality that is hold between the layers which makes it look simpler and perform eventually better in all means.

VGG model consists of fully connected and convolution layers. This model has a fixed input size of 224 x 224 x 3 and also the stride of 3x3. ReLu introduces the non-linearity concept to the model and also enhances its classification accuracy. The figure 3 below shows the architecture of VGG19 model.

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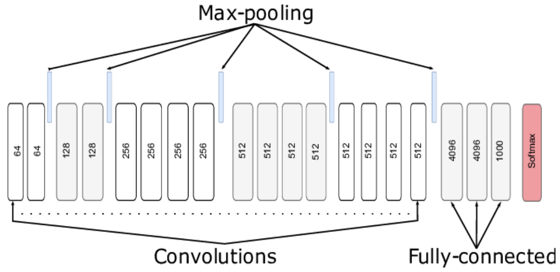

Figure 3. VGG19 Architecture

VGG networks are self-trained and Keras Library has built-in functions to implement VGG models such as VGG16 and VGG19. Function used is tensorflow.keras.application.VGG19() The input to the function is the shape, weights, padding, stride etc. The layers defined in the model can be seen in the model summary shown in figure 4 below.

Layer (type)	Output Shape	Param #
vgg19 (Functional)	(None, 5, 6, 512)	20024384
dropout_29 (Dropout)	(None, 5, 6, 512)	0
flatten_9 (Flatten)	(None, 15360)	0
batch_normalization_37 (Batc	(None, 15360)	61440
dense_27 (Dense)	(None, 2048)	31459328
batch_normalization_38 (Batc	(None, 2048)	8192
activation_6 (Activation)	(None, 2048)	0
dropout_30 (Dropout)	(None, 2048)	0
dense_28 (Dense)	(None, 1024)	2098176
batch_normalization_39 (Batc	(None, 1024)	4096
activation_7 (Activation)	(None, 1024)	0
dropout_31 (Dropout)	(None, 1024)	0
dense_29 (Dense)	(None, 4)	4100

Total params: 53,659,716
Trainable params: 33,598,468
Non-trainable params: 20,061,248

None

Figure 4: VGG19 Model Summary

C. Implementation

The process of deriving the results using all these models are done by taking the flowing steps into consideration. The work flow can be seen in the flow diagram that is shown below figure5.

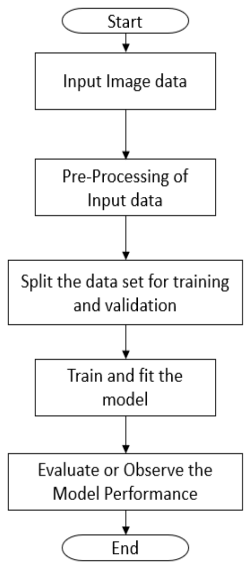

Figure 5: Flow diagram

The flow starts from input of image data which further is preprocessed by converting the labels of different categories to numerics using one hot encoding and getting the data set ready to train the model.

The snippet of the data set used and its respective labelling is shown in the figure 6 below.

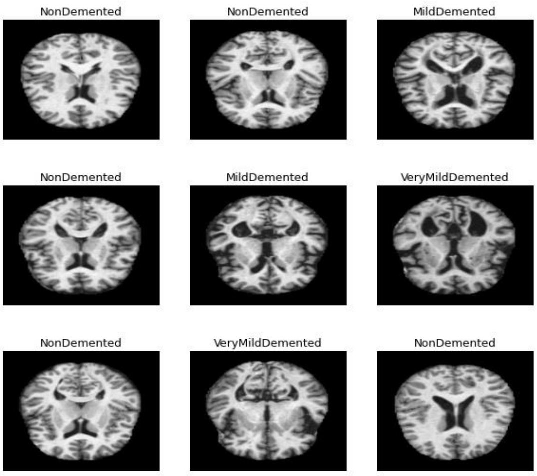

Figure 6: Snippet of data set.

The input data is trained on both the models and the performance metrics that is the results are observed accordingly.

III. Results

As the work is regarding the classification of images its is also important to take AUC metrics to evaluate the performance of the model and the results obtained are discussed below.

The CNN model shows moderate result with fluctuations in model loss and also in accuracy metrics. The model is on the whole providing an accuracy of 70%. The figure 7 shows all the performance metric curves of basic CNN model.

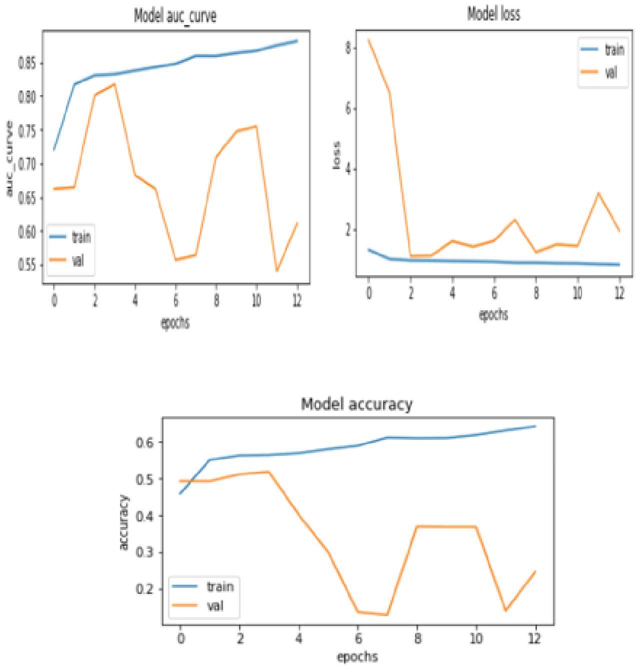

Figure 7: Performance Metrics of CNN Model

VGG19 model shows an exceptional performance with accuracy of 92% on validation set with very less model loss. Figure below shows the performance metric curves of VGG19 model

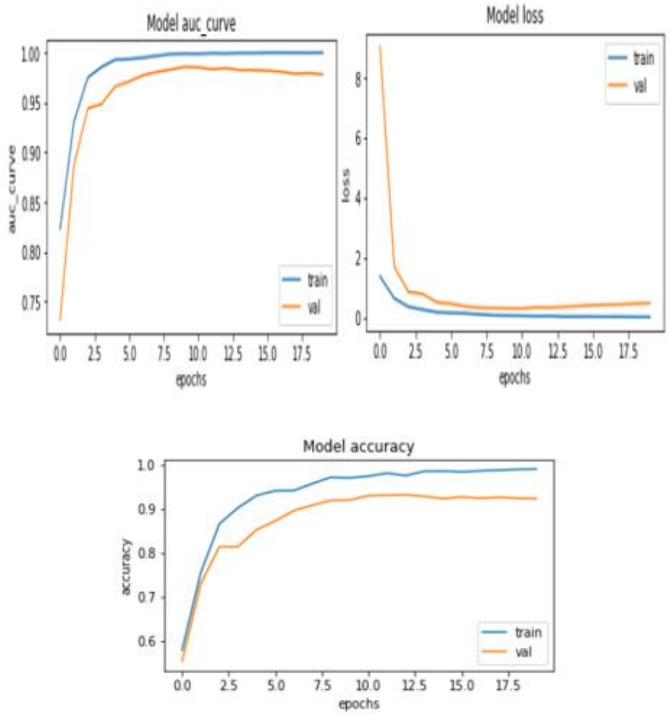

Figure 8: Performance Metrics of VGG19 Model

When put into comparison the VGG19 which is a deep neural network architecture standout by showing very high accuracy when compared to any simple architecture.

IV. Conclusion

The aim of the work to implement the neural network models CNN and VGG19 was carried out successfully and as the results we see that VGG19 architecture performs very well on provided data set. The performance metrics shows exceptionally normal curve of train and validation set providing an AUC of 0.97 and accuracy of 92%.

V. Future work

There can be more advanced models that can be considered for further implementation and also fine tuning of features can be done to increase the accuracy of the model. There can be prediction tests performed and also the process of prediction can be automated. There are many different approaches that can be taken to improvise the application and make it work in real time as an application.

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