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Research Article

A Deep Learning Approach for Pneumonia Detection and Classification

T.Daniya[1], R.Deepa[2], K. Suresh Kumar[3]

Abstract

Pneumonia is an illness, which happens in the lungs brought about by a bacterial disease. Early finding is a significant factor as far as the fruitful treatment measure. Largely, the illness can be analyzed from chest X-beam pictures by a specialist radiologist. The judgments can be emotional for certain reasons, for example, the presence of sickness, which can be muddled in chest X-beam pictures or can be mistaken for different infections. This venture proposes a Convolutional Neural Network model prepared to characterize and recognize the presence of pneumonia from an assortment of chest X-beam picture tests. Dissimilar to different strategies that depend exclusively on move learning draws near or conventional carefully assembled procedures to accomplish an astounding arrangement execution, we build a Convolutional Neural Network model without any preparation to extricate highlights from a given chest X-beam picture and characterize it to decide whether an individual is tainted with pneumonia. This model could help alleviate the dependability and interpretability challenges frequently confronted when managing clinical symbolism. As it is hard to acquire a lot of pneumonia dataset for this order task, along these lines, we might want to send some information increase calculations to improve the approval and characterization precision of the CNN model.

Keywords: Transfer learning, classification, Convolutional Neural Network, reliability, interpretability, data augmentation, validation.

1. INTRODUCTION

Deep Learning is a subset of AI in Artificial Intelligence. It is utilized to extricate helpful examples from both unstructured and unlabeled information. Computerized reasoning is a procedure, which permits the machines to act like people by repeating their conduct and nature. AI is a subset of Artificial Intelligence. It permits the machines to learn and make expectations dependent on its experience. The essential contrast between the customary Machine Learning and Deep Learning is the productivity. Deep Learning calculations require immense measure of information to yield versatile outcomes. Yet, when managing huge datasets Deep Learning calculations out performs Machine Learning. Deep Learning was apparent since seemingly forever in the set of experiences

[1]Assistant Professor, Department of Information Technology GMR Institute of Technology, Rajam, AP-532127 Email: daniya.t@gmrit.edu.in
[2]Assistant Professor, Department of Information Technology St.Joseph's College of Engineering, chennai-119. Email: deepa.deepavijay@gmail.com
[3]Associate Professor, Department of Information Technology Saveetha Engineering College, Thandalam, Chennai. Email: sureshkumar@saveetha.ac.in

yet was not mainstream until the new occasions.

Deep Learning is a Scalable Machine Learning. The primary difference between the traditional Machine Learning and Deep Learning is the efficiency. Deep Learning algorithms require huge amount of data to yield scalable results. However, when dealing with large datasets Deep Learning algorithms out performs Machine Learning. It has many hardware dependencies due to heavy matrix multiplication operations in implementing deep learning algorithms. In addition, traditional machine learning requires us to identify the features inherently present and then hand code as per the domain and data type. The Various deep learning application like forgery detection [7], text recognition [9], agriculture disease prediction [11], cancer prediction [13] and regression techniques [14] [15] are plays a vital role in research community.

Supervised Learning: Supervised learning means the machine is trained based on the labeled data, which predicts the outcomes for the unforeseen data. It requires highly skilled data scientists with technical expertise to maintain results and remain true until its data changes. It is highly accurate and trustworthy method.

Unsupervised Learning: Unsupervised learning is used to find the unknown patterns and features for categorization. It is used to perform complex processing tasks compared to the supervised. It is less accurate and trustworthy. The main drawback is that the output used in this is labelled and not known.

Self-Organized Maps: Self-Organized Maps reduces the dimensionality that is it reduces the amount of columns and converts the output to 2 dimensions. Without any labels, these can convert the data into maps by previous data. It resembles K-means Clustering in Machine Learning.

Boltzmann Machines: The previous models are directional whereas the Boltzmann Machines are unidirectional. There is no output layer in this. They generate the data in all nodes including visible nodes without any input also. They are also called as Generative Deep Learning Models.

Auto Encoders: Auto Encoders is a type of Artificial Neural Networks to learn a representation for a set of data used for dimensionality reduction. One of the major use-cases of deep learning is imaging analytics and diagnostics. A convolutional neural network (CNN) is well suited for analyzing images and one such problem statement has been raised by the RSNA, where we need to build an algorithm to detect a visual signal for pneumonia medical images. Specifically, it needs to locate lung opacities on chest X-Rays.

2. LITERATURE SURVEY

Rahib H. Abiye [1] proposes a Chest Diseases are intense medical issues in existence of individuals. Numerous procedures have been created for the early determination of these illnesses. The simplicity of ordering the chest illnesses in chest X-beams utilizing profound learning approaches is appeared in this paper. In addition, for comparative purposes the Back Propagation Neural Networks and Competitive Neural Networks with Supervised Learning are intended for symptomatic purposes. The organized Convolution Neural Network, Back Propagation Neural Network, and Competitive Neural Network were prepared just as tried using the chest X-Ray

pictures containing different ailments.

The Back Propagation Networks performed better compared to Competitive Networks when the examination depends on Recognition rates. Moreover, a CNN was likewise prepared and tried using a greater dataset, which was additionally used for BPNN and CpNN. It was seen that CNN Hieu H. Pham [6], beats BPNN and CpNN about Generalization Power in the wake of meeting yet the calculation time and number of emphases are very higher. This productivity is largely because of the profound construction of CNN, which utilizes the force of separating distinctive level highlights. This brought about a superior speculation ability.

Okeke Stephen [2], proposes a convolutional neural organization model, which is prepared without any preparation to recognize and group the presence of pneumonia from chest X-beam picture tests. Dissimilar to different Techniques, which depend exclusively on Transfer learning draws near and proposes conventional handmade methods to accomplish a noteworthy efficiency. To fit the little dataset into profound neural organization engineering, different methodologies like Data Augmentation, Learning Rate Variation and Annealing were utilized. It is seen that the precision decreases when the picture size is enormous. So we utilize little measured pictures to somewhat improve the proficiency and precision.

Jonathan Rubin [5], proposed an expanded profound learning way to deal with characterize pneumonia in chest X-Rays. We have amalgamated different novel procedures, which are being utilized in the current frameworks and concoct a superior test exactness. To carry out this, we have followed the accompanying strategies like Image Data Augmentation to the whole information set,Fine tuning of hyper boundaries, for example, Learning Rate, Batch Size, No of Epochs, optimizer,Experiment with different pre-prepared models(State of the craftsmanship designs) like Xception, Vgg 16, Resnet, Inception V3, Densenet for executing Transfer Learning,Compared every one of these exactnesses with the model worked without any preparation utilizing CNN,Improve the model precision to handle this present reality circumstances with more efficiency.,Predict the info Chest X-Ray is contaminated with Pneumonia or not.

Enes Ayan[3], conclusions of Pneumonia through Chest X-beam pictures may be abstract for certain reasons like the presence of infection which can be muddled or it very well may be mistaken for different sicknesses. In this way, PC supported demonstrative frameworks are needed to help the facilities .The paper proposed the utilization of two convolutional neural organization models like Xception and VGG16 for analysis of pneumonia. Calibrating and Transfer Learning approaches are utilized in this.The test results P Lahkani[12], demonstrated that Vgg16 network has higher effectiveness than Xception network by precision of 87% . As opposed to this, Xception network has higher affectability of 85% than the VGG16 organization. The outcomes showed that each organization has its own choice capacity on the dataset. It has been inferred that Xception Model performs better in the situations where the individual has pneumonia and the VGG16 model performs better in the typical cases.

Pranav Rajpurkar[4],plans a calculation that can recognize pneumonia from chest X-beams at a level outperforming radiologists. The proposed calculation is called CheXNet. It is a 121-layered convolutional neural network (CNN) and it is prepared on ChestX-Ray14. It is as of now the greatest unreservedly accessible chest X-beam dataset. It contains more than 100,000 front facing

view X-beam pictures with 14 diseases. Andr´e Gooßen[8],shows that a slight augmentation of this calculation to recognize various infirmities and has a slight edge over the past best in class on ChestX-ray14. Augmentation of the calculation to order extraordinary thoracic pathologies is by making three varieties. First: Xiaosong Wang [10], proposes to ouput a vector of Binary Labels each showing the presence and nonappearance of 14 infections as opposed to accepting one twofold name as the yield. Second: Replacing the last completely associated layer with a completely associated layer with 14-dimensional yield.

3. METHODOLGY

Data preprocessing: Data pre-processing is an important step in this process. Data-gathering methods are often loosely controlled, resulting in out-of- range of values, impossible data combinations, missing values, etc. Analyzing data that has not been carefully screened for such problems can produce misleading results. If there is much redundant, irrelevant, are noisy and unreliable information present, then knowledge discovery during the training phase is more difficult. Data preparation and filtering steps can take considerable amount of processing time. Data preprocessing includes cleaning, normalization, transformation, feature extraction and selection, etc.

Convolutional Neural Network: In this step feature, detection takes place. Feature detectors like Sharpen, Blur, Edge Enhance, Edge Detect, and Emboss are used to convert the pixel values into binary values. After applying feature detectors we get many number of pooled feature maps. We use activation function called as RLU (Rectified Linear Unit) to increase the non-linearity in our images.

Max Pooling: As we get many number of pooled feature maps it is difficult for computation hence we use max pooling for computation.

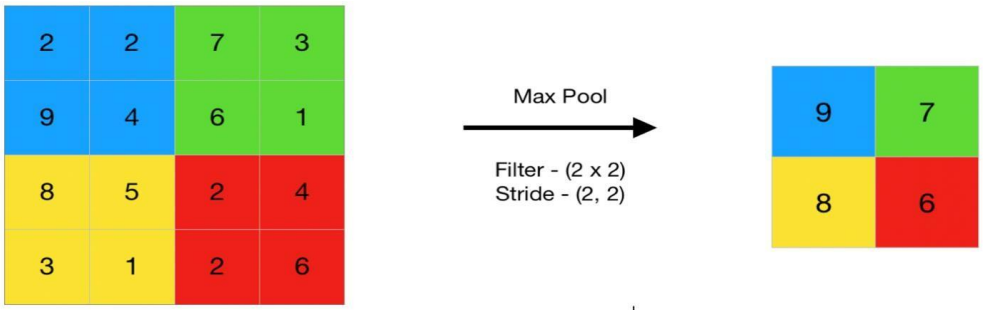


Figure. 3.1 Example of Max Pooling

Flattening: To insert all the pooled feature maps into ANN they should be in vectors i.e. 0/1 matrix form we do this process in a flattened layer, so it is called as flattening. Hence, all the pooled feature maps come into a single vector.

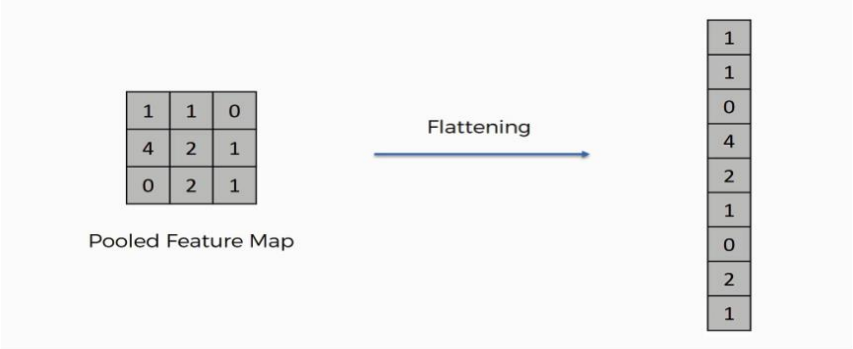


Figure 3.2 Image displaying Flattening process

Full Connection Loading and Preprocessing Of Data: The dataset of 5800 images is uploaded into the Google Drive. Google Co lab is then mounted to the Google Drive in which the images are uploaded. The path of the folder in which the images are present is taken and we build the loop for every image and take them into a numpy array as in deep learning everything is represented in arrays. The dimension of the array is increased, as the model we are going to deal with, needs four dimensions as an input. Pre Processing the data is required in order to get the data into the desired quantity. There is a function called as Preprocess input in VGG model for converting every image into the shape that model works the best.

Splitting the Data into Test and Train: Testing the model for the data from which it is not trained plays an important role in determining the efficiency of the model. If the model has high accuracy on train set and low accuracy on the test set the model is said to be overfitting. If the model has, less accuracy on both Train set and test set it is said to be underfitting and the features taken are not enough. Bias and Variance are two terms, which plays an important role in the determination of the efficiency of the mode.

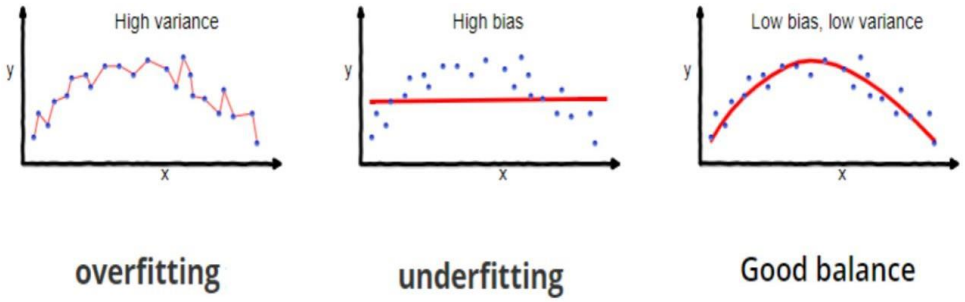


Figure 3.3 Fittings

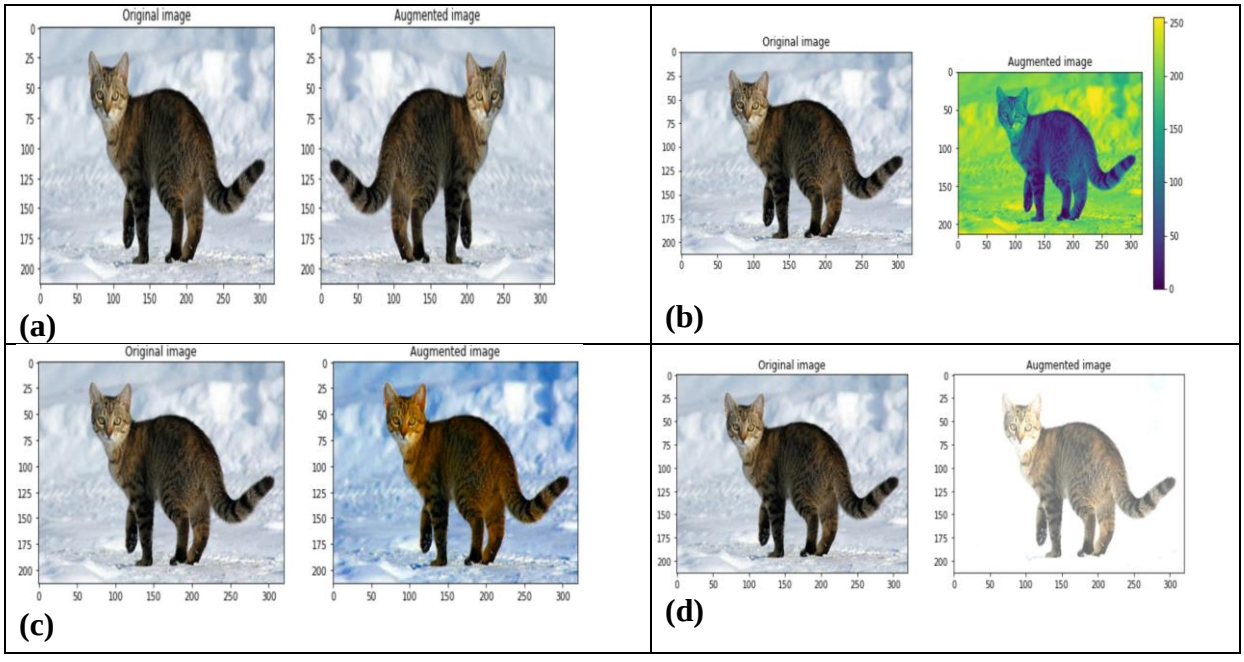
So in order to avoid overfitting and under fitting the model should have lower bias and variance. To do that the following procedure is followed. We divide the data with us into Test and Train. If we have enough data, the validation is also split to get the result finally. 80 % of the data should be in the train set and the rest of the 20 % should be in test. 5% of the data can also be used as the validation set for visualizing the results at the end.

Data Augmentation: Data Augmentation is a technique which is used to diversify the datasets without actually collecting the data again. It is a simple and common technique which avoids overfitting. In many cases it is said to be improving the results. A neural network which classifies the objects even if they are in different orientations is said to be having Invariance.

Building a Model: The classic and most popular use case of the neural networks is the Convolution Neural Networks. The model we built is based on a Convolution Neural Networks (CNN) model, which is widely used in the field of Computer Vision. CNN is a process where the images are read and the necessary processing is done.

Convolution Neural Networks: This sounds like a weird biological term mixed with the math and little bit of Computers. The input to the neural network is an image. What we see is very different from what computers actually see in an image. The computer sees a 32*32*3(3 corresponds to the 3 layers i.e. RGB) array of numbers which is based on resolution and size of the image. The values in the array are the pixels, which range from 0 to 255. The value of the pixel depends on the intensity of the image at that particular pixel.

Fully Connected Layers: In this step, we add an entire new Artificial Neural Network to our CNN. In the ANN, these are called as hidden layers and in here, they are called fully connected layers because they are hidden layers. However, they are a bit different from the hidden layers in the ANN because in there the hidden layers may or may not be fully connected. In addition, so that whole column or vector of outputs that, we have after the flattening; we are passing it into the input layer. We have features encoded in the vector which when input to the fully connected layers can do a great job at predicting. When regression you output only one class but for a classification problem you need at least two classes as the output.



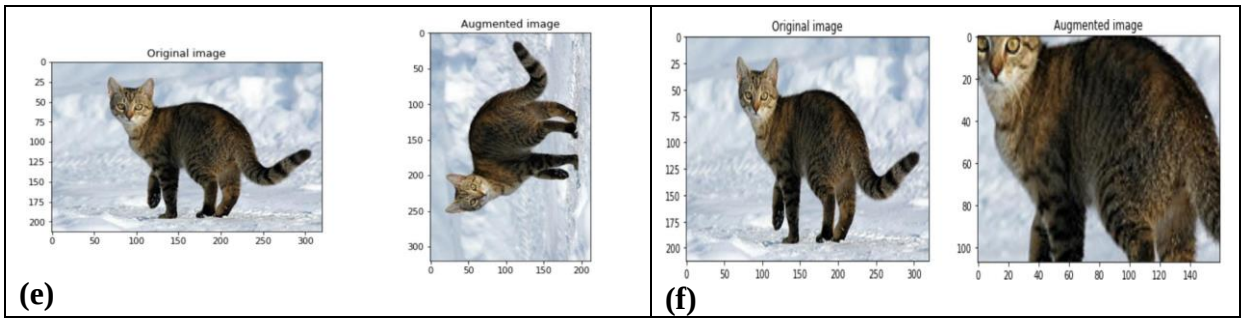


Figure 3.4 (a) Flip (b) Gray scaling (c) Saturation(d) Brightness (e) Rotation(f) Cropping

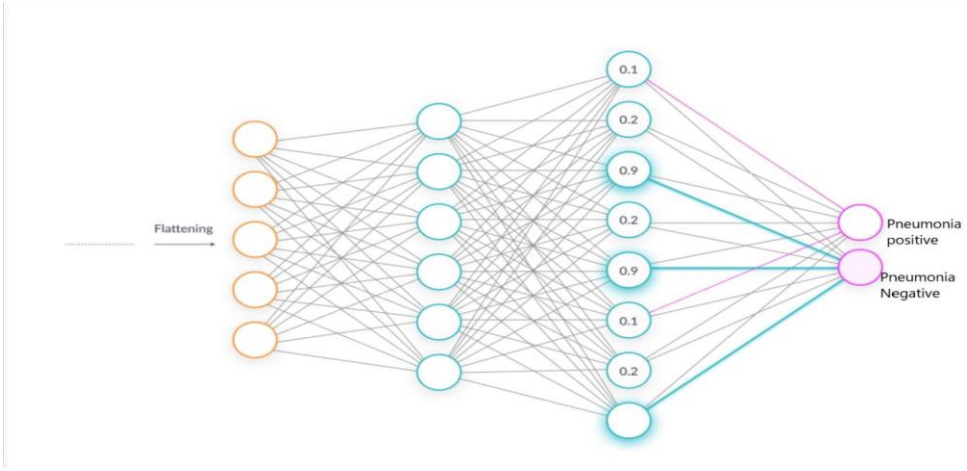


Figure 3.5 Flattening and FCL internal process

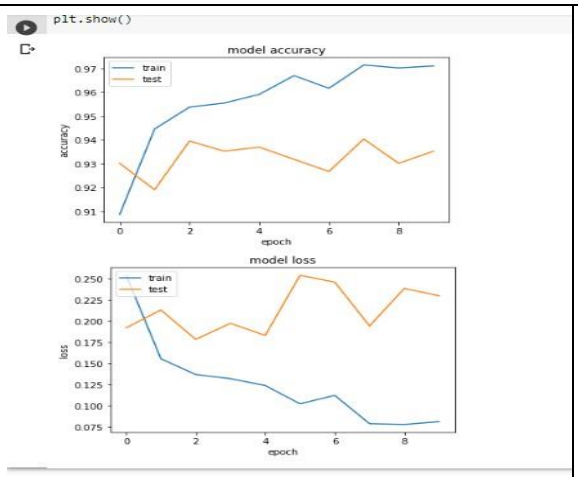
In artificial neural network, the cost function which is used to calculate the error but we use a loss function and for that, we use a function called as cross entropy function in classification and mean squared error in regression in CNN. Therefore, the important thing here is that the data goes through the whole network from the very start to the very end and then the error is compared. The error is back propagated and the feature detectors are adjusted in such a way that the error is reduced. The first neuron, which specifies the Pneumonia positive, sees which neurons correspond for the positive and take the output from them only and the same with the negative neurons. For the final layer the activation function would always be a sigmoid or a softmax function. Both the activation functions give out the probability that each class is identified.The main difference between a sigmoid function and a softmax function is that the sigmoid function gives out probability that each class is found and it may or may not be equal to one which is contradicting

the basic mathematical rule. Whereas a softmax function gives probabilities and make sure that when we add all the probabilities we get the sum as 1.

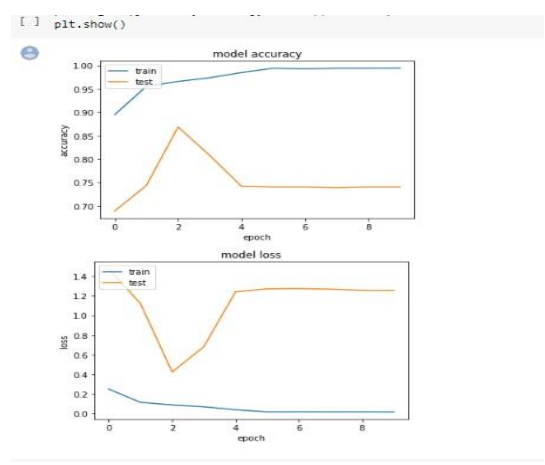
4. RESULTS AND DISCUSSIONS

Data Set Analysis: The data set for detecting pneumonia from chest X-ray images is downloaded from Kaggle website, and is shown below. We will be using labeled Chest X-Ray images to train a model for pneumonia detection. The dataset is hosted on Kaggle and consists of 5,863 X-Ray images. The pneumonia images are further categorized as viral or bacterial. Ignoring this secondary categorization, our model will classify images as pneumonia or normal.

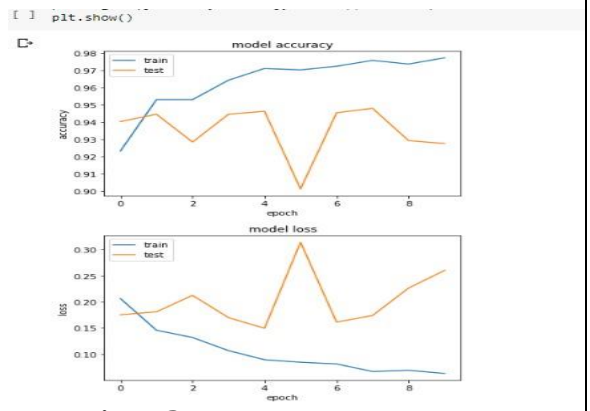
Model Comparison: Here we present our results based on the various pre-trained models we have used for training the model using transfer-learning techniques. The pre-trained models used are VGG 16, VGG 19, Inception V3, Xception, ResNet, and Efficient Net.Below are the graphs plotted between the no of epochs vs the model accuracy and loss



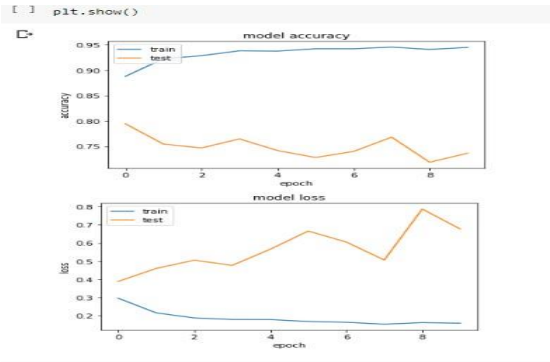
VGG16



VGG19



InceptionV3



Xception

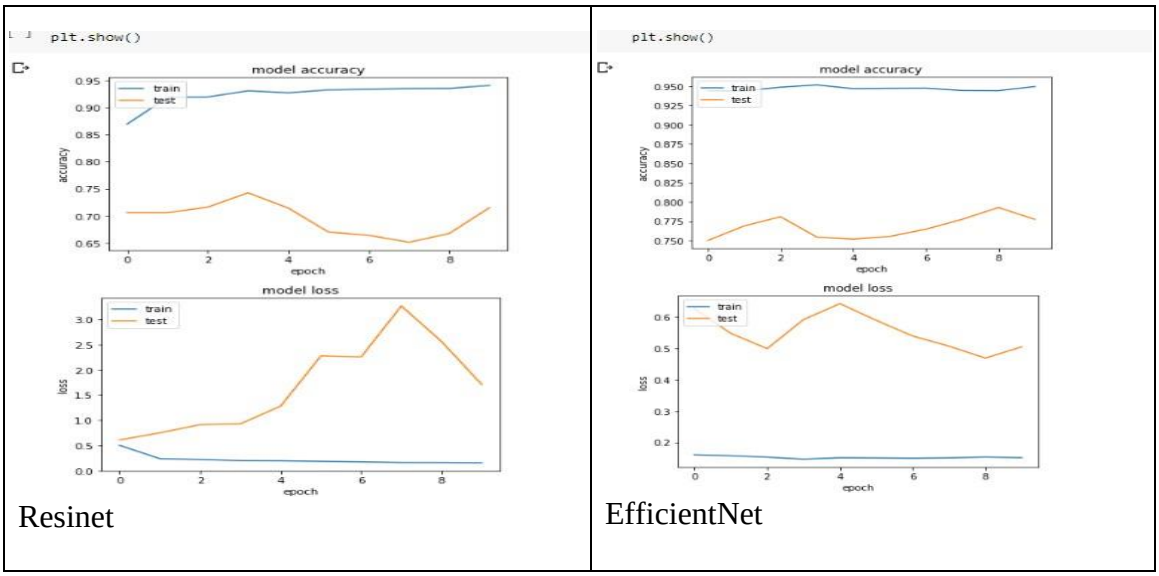


Figure 3.6 Various Models

Table 4.1 : Tabular comparison of models

S No	Model	Train Accuracy	Test Accuracy	Validation Loss	No Of Epochs
1.	VGG 16	97.74%	93.78%	0.224	10 / 10
2.	VGG 19	97.5%	92.75%	0.262	10 / 32
3.	INCEPTION V3	99.42%	74.04%	1.255	10 / 64
4.	XCEPTION	94.5%	73.66%	0.6767	10 / 10
5.	RESNET	94%	71.53%	1.7060	10 / 10
6.	EFFICIENT NET	94.9%	77.75%	0.5030	10 / 32

5. CONCLUSION AND FUTURE SCOPE

We fostered a model to recognize and characterize pneumonia from chest X-beam pictures taken from front facing sees at high approval precision. The calculation starts by changing chest X-beam pictures into sizes less than the first. The subsequent stage includes the recognizable proof and order of pictures by the convolutional neural organization structure, which concentrates highlights from the pictures and groups them. Because of the viability of the prepared CNN model for distinguishing pneumonia from chest X-beam pictures, the approval precision of our model was essentially higher when contrasted and different methodologies. To confirm the exhibition of the model, we rehashed the preparation interaction of the model a few times, each time acquiring similar outcomes. This will go far in improving the wellbeing of in danger youngsters in energy-helpless conditions. The examination was restricted by profundity of information. With expanded admittance to information and preparing of the model with radiological information from patients and no patients in various pieces of the world, huge upgrades can be made.We have exhibited how to group positive and negative pneumonia information from an assortment of X-beam pictures.

Later on, this work will be stretched out to distinguish and group X-beam pictures comprising of cellular breakdown in the lungs and pneumonia. Recognizing X-beam pictures that contain cellular breakdown in the lungs and pneumonia has been a major issue lately, and our methodology will handle this issue later on.

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