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A Study to Evaluate the Model for the Pneumonia Detection Using Deep Learning

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ABSTRACT

Pneumonia is an illness that attacks the respiratory system, by affecting or damaging air sacs of the lungs and filling them up with fluid. It is caused by microbes such as Viruses, Fungi, and Bacteria, lungs become swollen and congested, leading to reduced oxygen exchange, which results in coughing and shortness of breath. It affects people of all ages, but the level of contact with children and people over the age of 65 is high. Pneumonia causes a significant number of losses of human lives all over the world, with 15% of children worldwide dying from pneumonia.

Historically, in developed countries, deaths from pneumonia have been reduced due to improved living conditions, air quality, and diet. In the developing world today, the high death toll from pneumonia can be prevented by vaccination or by simple, effective treatment As technology grows faster, people are developing new technologies in the world of computers and IT every day; it is time for the world to introduce automated systems for managing all health care facilities. In this project, we have managed to detect pneumonia in a patient, through his X-rays. Earlier, a medical professional or a trained physician was required to read the X-ray and diagnose the patient.

1. INTRODUCTION

Pneumonia is one of the deadliest lung diseases caused by either Viruses, Fungi, or Bacteria. It affects a large number of people worldwide each year (about 4 million fatalities based on WHO's Research). Every year 1.9 million children under 5 years of age die from pneumonia. It is, however, a manageable disease if it is discovered in the early and patient gets treatment accordingly. Pneumonia fills up the air sacs with Pus or Fluid and can be dangerous to health for anyone (Especially infants, children, and the elderly). Symptoms may include cough with phlegm or pus, fever, chills, and difficulty breathing. Antibiotics and Vaccines are available to treat Pneumonia. Most popular way of detecting the pneumonia in patient is to go through their X-rays, and determining whether they have pneumonia in their lungs or not. But, to go through a patient's X-ray, it requires a trained physician or a medical professional/medical officer. Not only this process is time consuming but it is also costly and the process is quite complex.

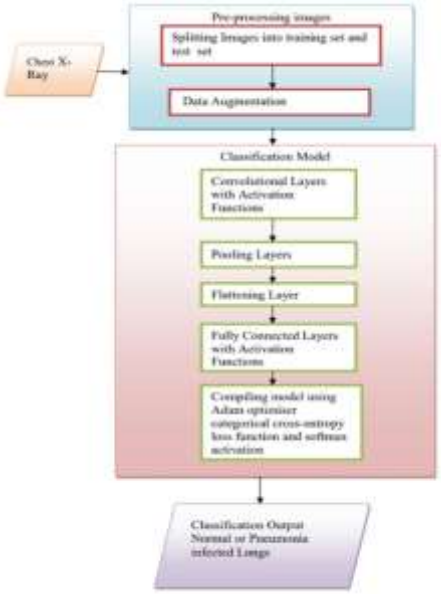


Fig 1: Flow Chart

In this project, we have successfully developed a model to determine whether a patient has pneumonia or not. Models of the convolutional neural network were demonstrated in this study to diagnose defective lungs accurately and affectively from X-rays. This model is trained to detect the pneumonia in a patient's body, simply by passing its X-rays, as it is trained to differentiate between a normal x-ray and x-ray of patients who are diagnosed with Pneumonia. A specified number of permutations of Conv2D, dropouts and dense layers are required training to achieve the best results. This is done by examining the model after each repetition. In the dataset, the basic model with only one Conv2D layer was initially considered for training, and complexity was raised until the model acquired the required accuracy. The purpose of this work is to create a custom CNN model that can detect pneumonia by going through x-rays with high accuracy and low loss of data.

2. LITERATURE REVIEW

Diagnosis of chest X-rays is a long-standing issue, the main obstacle being the lack of available information. General deep learning strategies have been well researched. Chandra et al. identified eight statistical features in different regions of the lungs in a database containing chest X-rays, which were used to classify them. Multi-layer perceptron (MLP), Random Forest, Logical Regression, Sequential Minimal Optimization (SMO), and classification via regression, were five different dividers used to achieve the desired goal. They tested their method in 412 samples and found that the MLP filter had 95.39 percent accuracy. In 185 patients with schizophrenia, Kuo et al. used 11 factors to diagnose the disease. They compared the effects of these attributes on different classification and regression models. They used the decision tree model to achieve the highest level of accuracy, 94.5 percent. Yue et al. used six pneumonia detection features on CT scan of 52 patients' patients, with a high accuracy rate of 97 percent. These tactics, however, cannot be generalized and tested only on limited databases.
Wang and Xia used ResNet's modified architecture to propose a comprehensive transmission method to diagnose multiple thoracic diseases, pneumonia is one of them, using chest radiography (He et al., 2016). Their model called ChestNet was tested on three other in-depth learning models. To achieve this result, they used a powerful computer configuration and 20 hours of training in the CAFFE framework (Jia et al., 2014).

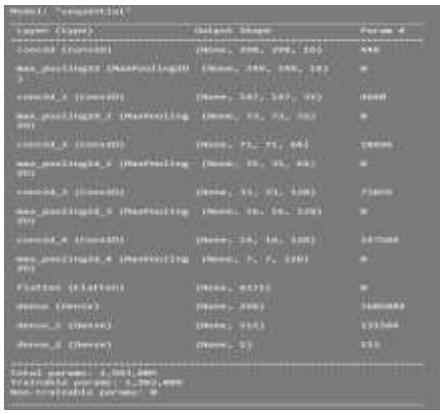
3. RESEARCH METHODOLOGY

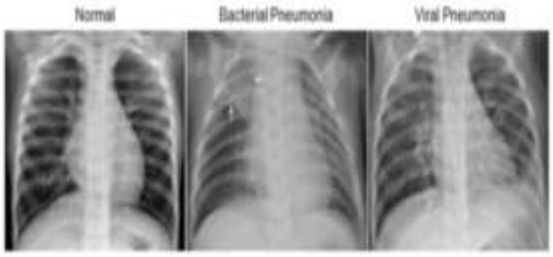
The CNN model was built and trained in a database containing Chest X-Rays and scanners. CNN is extremely good at identifying object, face, and image. The model was created using the Keras neural network framework and then the backend is created using TensorFlow. The input data set contains 5318 training images and 764 images for testing purposes. Each image is classed as either normal or pneumonia. Twenty-five Epochs were used used to train the model in batch sizes thirty-two and one for training and testing, respectively.
First, we split our Data set into two Parts, to keep Normal X-rays and X-rays of Patients which have Pneumonia. We've also resized the pictures to form all the photographs of same size, so we are able to apply same changes to all the images and plot them on the graphs later.
After resizing, we are also going to resize, zoom and shake the images a little just to imitate the behaviour of the doctor or medical expert, who reads the X-rays of patients.
This proposed model has two activation functions: ReLU and sigmoid activation function. The Rectified linear function is a nonlinear function that gives zero and one as results. When the input is negative, it gives zero and produces one as an output when it is positive. This activation function actually increases non-linearity in our custom -built model. The final dense layer that collects all of the previous layers' output uses the sigmoid activation function because binary classification output was required.
It is not a predefined model like AlexNet, VGG16, VGG19, GoogleNet, etc, but a deep and customized CNN model. Because it has many layers namely, convolutional layers, pooling layers, flatten layers, dense layers.

Data Set:

Data set is imported from Kaggle, the dataset consists of:

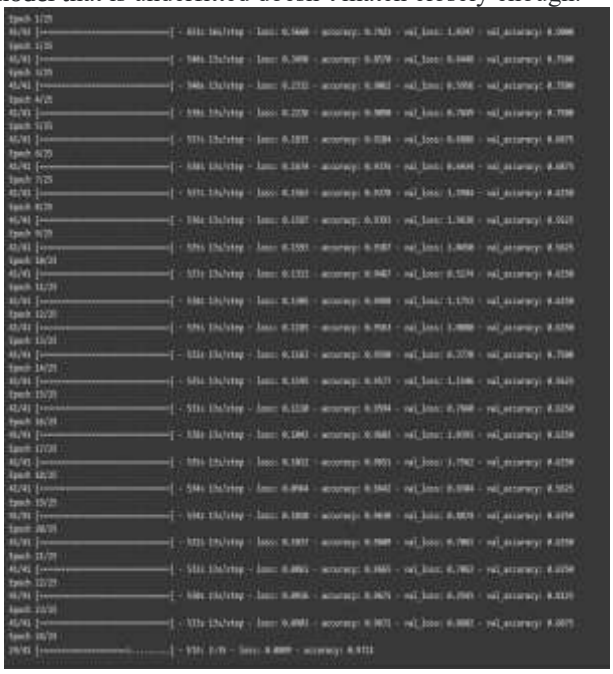
- 5216 training images of which 3815 are of Pneumonia and 1341 are normal images.
- 624 testing images of which 390 are of Pneumonia and 234 are normal.



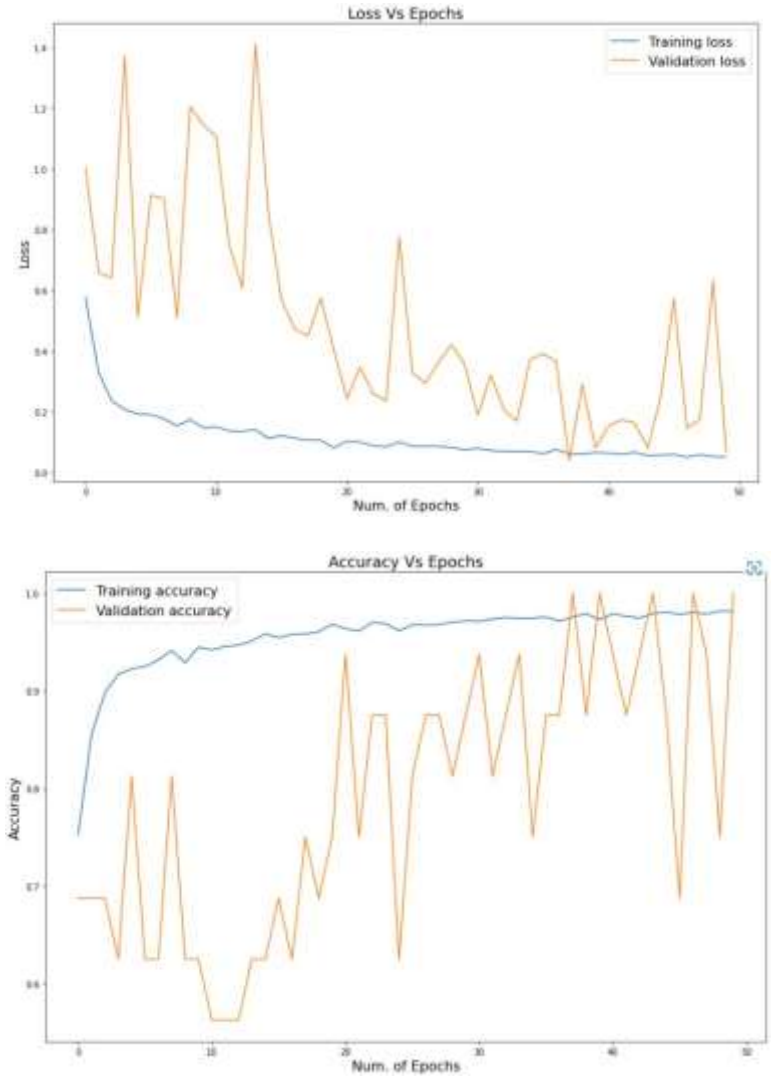


4. RESULT

This model is 97.21% accurate, accuracy score was used as the permitter to determine the accuracy of the model.
Epoch: an arbitrary cutoff, generally defined as "one pass over the entire dataset", used to separate training into distinct phases, which is useful for logging and periodic evaluation.
So, in other words, a number of epochs means how many times you go through your training set. The model is updated each time a batch is processed, which means that it can be updated multiple times during one epoch. If `batch_size` is set equal to the length of `x`, then the model will be updated once per epoch.
Fit: Model fitting is a measure of how well a machine learning model generalises to similar data to that on which it was trained. A model that is well-fitted produced more accurate outcomes. A model that is overfitted matches the data too closely, and a model that is underfitted doesn't match closely enough.



Model Accuracy



5. CHALLENGE FACED

Pneumonia is an inflammatory condition of the lung affecting primarily the small air sacs known as alveoli caused by infection with viruses or bacteria. So, a model capable of detecting pneumonia inside a patient's lungs was a huge challenge. Few challenges we faced are listed below:

- Diagnosed by symptoms, physical examination, chest X-ray, blood tests. Severity is variable especially in developing countries. Thus, early-stage diagnosis is very crucial.
- To Improve the accuracy from the previous model, we had to build a new CNN model to increase the Accuracy.
- Scarcity of the Dataset was one of the main Obstacle the research.
- The Model should be easy to use, so that further development can be done based on this research.

6. CONCLUSION AND FUTURE WORK

Pneumonia is one of the deadliest lung diseases caused by either Viruses, Fungi, or Bacteria. It affects a large number of people worldwide each year (about 4 million fatalities based on WHO's Research). Pneumonia fills up the air sacs with Pus or Fluid and can be dangerous to health for anyone (Especially infants, children, and the elderly). Also, it requires a medical professional or trained physician to determine whether the patient has pneumonia or not. Our model with the accuracy of 97.21%, can solve this problem. It can detect the pneumonia, inside the lungs of the patient, by using the patient's x-ray. Due to highly accurate model, a strong medical system can be created, in which a patient can be diagnosed without going to the medical professionals, not only that it will save the time of the medical professionals also.

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