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Chronic Disease Detection Using Deep Learning

Vinay Kumar Singh Shiva Khattri Dr. Om Prakash Yadav Prabin Raymajhi

CSE, Lovely Professional University, Punjab

ABSTRACT

Pneumonia is a life-threatening and contagious disease of the respiratory system caused mainly by bacteria, fungi, or viruses that infect a person's lungs with a load of fluid. Common technique are used to diagnose pneumonia is chest x-ray report and it needs a medical professional to evaluate the outcome of the X-ray report. Earlier troublesome methods of detecting pneumonia increase mortality due to unawareness with improper diagnosis and treatment. Computer technology is emerging these days, the development of an automatic system to identify pneumonia and treating the disease is now possible especially if the patient is in a distant area and medical services are limited. The main aim of this paper is to identify pneumonia automatically using X-rays images. This study will provide accurate detection of pneumonia and intends to apply deep learning methods to ease the problem. Convolutional Neural Network is highly optimized that perform the complex task of detecting diseases like pneumonia to assist medical experts in the diagnosis and possible treatment of the disease. This model is trained to classify between normal and pneumonia from the chest X-ray images. The first model achieves an accuracy of 95.64% and the second model achieves accuracy of 94.92%. Adam optimizer is used to optimize the model.

Keywords: Pneumonia, Chest X-ray, Convolutional Neural Networks, Disease Detection.

1. INTRODUCTION

Pneumonia is a form of respiratory infection that affects the lungs. The lungs have tiny sacs that is called alveoli, which fill the air through wind pipe when a healthy person is breathing. When a person is suffering from pneumonia, the alveoli become filled with pus and fluid, making breathing difficult and reducing oxygen consumption.

Pneumonia is the single largest deadly disease that cause death in children worldwide. In 2017, 808 694 children under the age of 5 were dead from this deadly disease. Pneumonia cases come from everywhere in the world but is most common in South Asia and sub-Saharan Africa. Currently diagnosing from chest X-ray is the best method to identify pneumonia. There are many biological complications which are using Artificial Intelligence based solutions. Till now, Convolutional Neural Network has shown efficient and precise result in image classification that's why research community is adopting it. Chest X-ray images dataset is taken from Kaggle where 5216 images is split to train and 625 for testing purpose. Data augmentation is used along with CNN to get better result by training the model on the small set of images. The highest accuracy reported in the model is 95.64% with loss of 11.09%. Therefore, there is significant chance of improving the accuracy of the model by modifying it or by using different algorithm techniques. This paper will provide all the methodology used details and approach.

2. METHODOLOGY

CNN models have been created and trained on the Chest X-Ray Images dataset on Kaggle. TensorFlow backend is used to implement the models. In the dataset, 5216 images are for training, 624 images are for testing and 16 images are for validation.

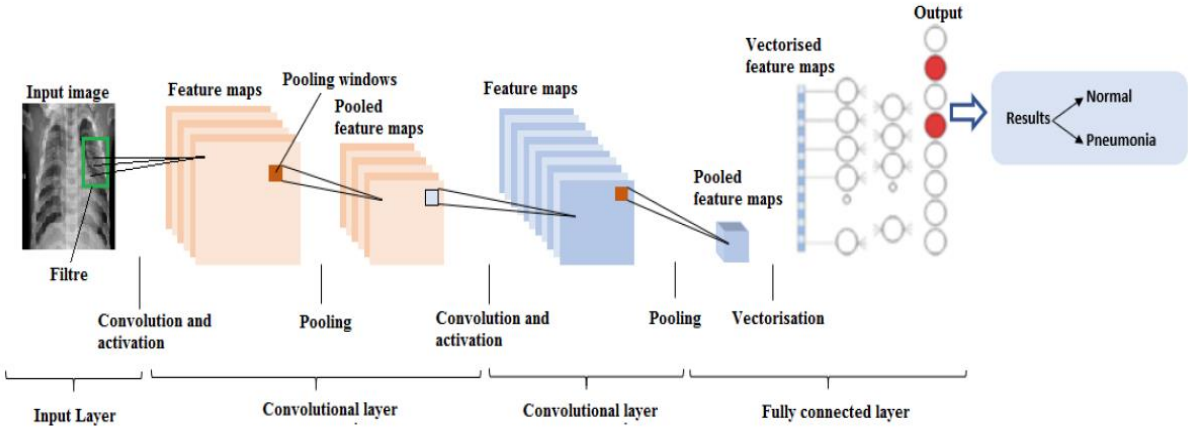

Figure 1: CNN Layer

To achieve a better result from the dataset, Data augmentation has been applied. All the models have been trained on a training dataset, each of them having a different number of convolutional layers. It is trained for 10 epochs, with training and testing batch size of 64.

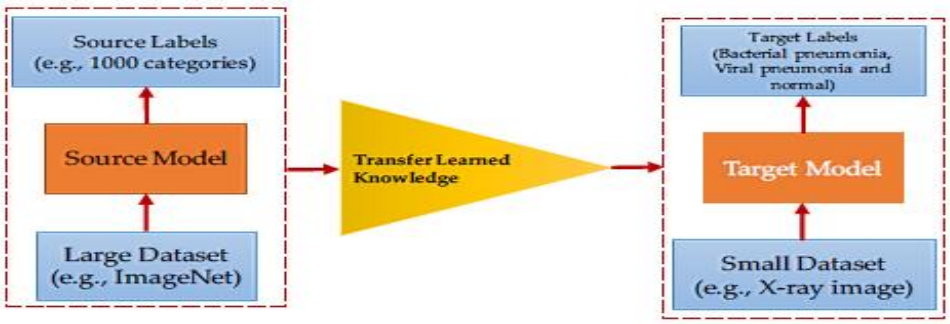

Figure 2: Data augmentation

3. CNN ARCHITECTURE

CNN models work as feed forward networks with convolution layers, flattening layers, and pooling layers where these layers employ suitable activation functions.

i. Convolutional layer

It is used as a building block of CNN. It uses the mathematics method to merge two functions. In CNN models, all the input images are converted into matrix form before passing it to the model. Convolution filter creates a feature map and generally assigns 3 X 3 for black and white 2D images. Convolution stores 3D connection between pixels by RGB color representation.

ii. Activation function

Two different activation functions, namely ReLU and softmax are present in all four models. The ReLU activation function is called a rectified linear function. It is a non-linear function and gives zero output when the negative input is given while gives output as one, the positive input is given. It is mostly used in CNNs and able to solve vanishing gradients problems. Softmax activation function works as a

normalizer as it normalizes the input into a probability distribution.

iii. Pooling layer

After passing input images from convolutional layers, a pooling layer is used to down the sample images and to reduce the dimension and complexity of the images. The Max pooling technique is used in this model to recognize the salient features in the image.

iv. Flattening layer and fully connected layers

After passing the input images to the convolutional layer and pooling layer, It is fed into the flattening layer. This layer automatically flattens the input images into a column and

reduces computational complexity. After this, it is passed into the fully connected and dense layer. The fully connected layer contains multiple layers, where every node in the first layer is attached to all the nodes of the second layer. In each layer, the network makes a prediction based on extracted features from the fully connected layer and this process is called forward propagation. We have calculated the cost function to measure the performance of a neural network model until it achieves optimized performance.

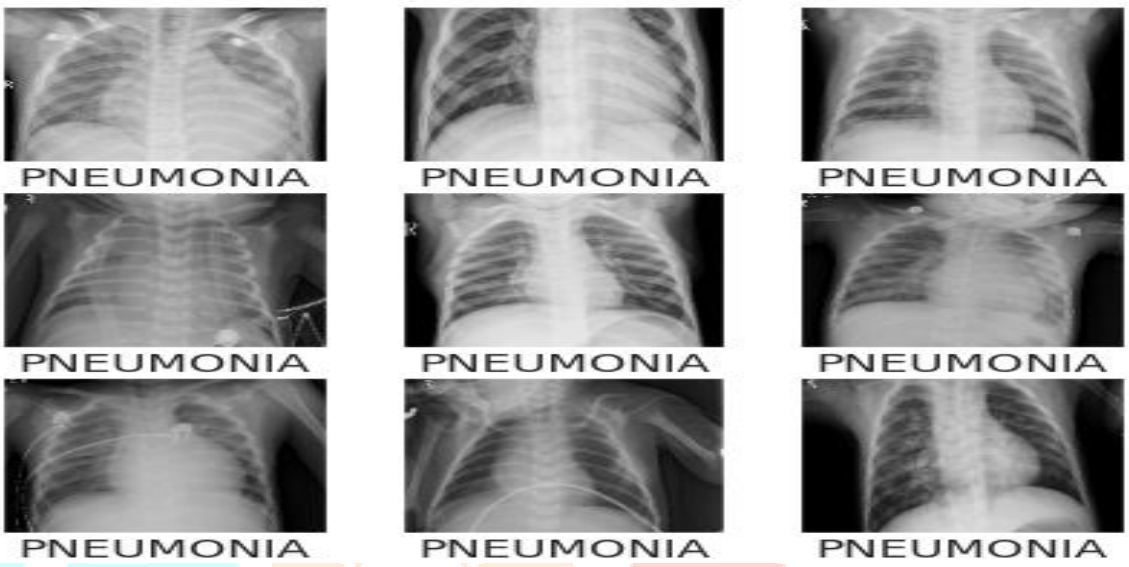

Figure 3: Sample X-Ray image detecting pneumonia

v. Algorithms of CNN classifier

In the convolutional neural network layer, the classifier is explained in the flow chart. The number of epochs used in the model is 10. There are several optimizers trained in the model. Adam optimizer is used because it was showing the best result with the classifier. The classifier model is having a 64 *64 convolutional layer of the image, 32 feature maps and ReLU activation functions are used. In a fully dense layer, 128 perceptrons are deployed. The final classifier model is trained with a 256 feature map in the convolution layer.

vi. Dataset

The chest X-Ray images(pneumonia) dataset is taken from Kaggle which is 1.15 GB in size. It has 5216 jpeg images for the split to train and 625 jpeg images for testing purposes. It has two subclasses named folder normal and pneumonia. Chest X-Ray image belongs to the age group between 03 - 60 years old.

4. EXPERIMENTAL RESULT

There is a minor loss in the model, which means the model is optimized. CNN classifier model, validation accuracy, and recall were evaluated as a performance measure to study the performance of each convolutional model. The accuracy graph shows both the accuracy and loss function graph.

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Epoch 1/6
66/66 [==============================] - 62s 937ms/step - loss: 0.1959 - accuracy: 0.9192 - val_loss: 0.1732 - val_accuracy: 0.9272
Epoch 2/6
66/66 [==============================] - 62s 935ms/step - loss: 0.1415 - accuracy: 0.9453 - val_loss: 0.1965 - val_accuracy: 0.9234
Epoch 3/6
66/66 [==============================] - 62s 941ms/step - loss: 0.1443 - accuracy: 0.9415 - val_loss: 0.2915 - val_accuracy: 0.8812
Epoch 4/6
66/66 [==============================] - 62s 942ms/step - loss: 0.1335 - accuracy: 0.9468 - val_loss: 0.1429 - val_accuracy: 0.9444
Epoch 5/6
66/66 [==============================] - 62s 935ms/step - loss: 0.1209 - accuracy: 0.9518 - val_loss: 0.1436 - val_accuracy: 0.9416
Epoch 6/6
66/66 [==============================] - 61s 932ms/step - loss: 0.1109 - accuracy: 0.9564 - val_loss: 0.1365 - val_accuracy: 0.9492
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Figure: 4 Accuracy Chart

All the results are satisfactory. There is 11.09% loss for training and 13.65% validation loss in the model. Therefore, model is precise and performed well on Chest X-ray images dataset. It has future scope in medical field for diagnosing such type of diseases and helping in reducing mortality rates.

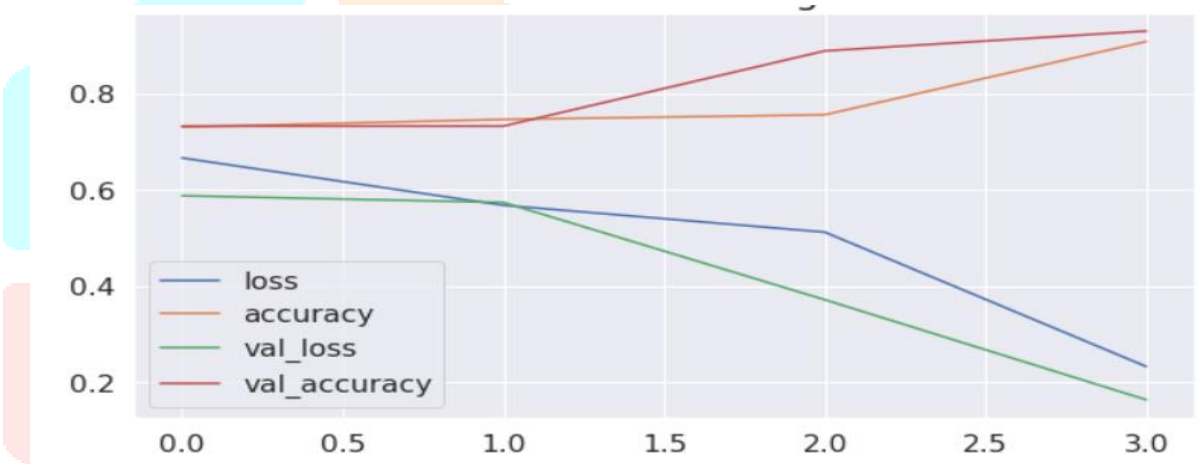

Figure: 5 Loss for Training

5. CONCLUSION

The validation accuracy and F1 score of the CNN classifier model are 93% and 95.20% respectively for the convolutional layer. The dataset was totally precise and model accuracy is quite high. As we are getting a high recall value, it will show a more precise diagnostic record and could be more helpful for doctors. It will be scanning a large number of X-Ray images in less time which will reduce the risk of a patient's life. This model provides the totally precise diagnostic result and early detection of pneumonia in patients; thus it will help the healthcare system to provide medical care to the patient and helps in reducing mortality rates.

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