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A Deep Learning Approach to Detect COVID-19

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ABSTRACT
Covid-19 is a viral disease that has been spreading rapidly infects both human beings and animals. The lifestyle of people, their physical and mental well-being and the economic condition of a country are distressingly disturbed due to the viral disease. Recently, vaccines have been prepared for COVID-19 which have quite winning results. Yet we are unsure about thelong-term effects of the vaccine. In a clinical study of COVID-19 infected patients shows that the covid patients are more likely to be infected from a lung infection after coming in contact withthe virus. Chest x-ray (i.e., radiography) and chest computed tomography (CT) are a more effective imaging technique fordiagnosing lung related problems. Yet, a significant chest x-rayis a lower cost process in comparison to chest CT. Adding to the previous statement, a chest X-ray helps to identify unusual and abnormal formations of a large variety of chest diseasessuch as pneumonia, cystic fibrosis, emphysema, cancer, etc. Deeplearning is the most successful technique of machine learning, which provides useful analysis that can detect the COVID-19 virus and differentiate between a healthy lung and a virus infected lung successfully. Medical imaging, such as X-rays and CT scans, can aid in the early diagnosis of COVID-19 patients, allowing for more prompt therapy. For prediction, a Convolutional Neural Network (CNN) extracts information from chest x-ray pictures has been done. In order to classify an image as COVID or normal we need to havea segmented target so as to obtain this we use filters so thatwe can get the edge of the image. Keras Image Data Generator class is used to generate augmented images. Classification is performed with two classes: COVID-19 and Normal.

Keywords: *Convolutional Neural Network, Deep Learning,Computer Tomography, Machine Learning, Recurrent Neural Network.*

1. INTRODUCTION

Deep learning (DL) is a subgroup of machine learning that deals in processing of knowledge and creates patternsthat helps in decision making. Deep learning is gleaned from Artificial Neural networks. Deep learning is a high- level knowledge abstraction model that comprises random transformations. The concept of deep learning to machine learning community was introduced by Rina Dechter in the year1986. Later in 2000 Igor Aizenberg initiated deeplearning to artificial neural networks.

Deep learning is especially the sort of ancient machine learning that involves two phases. Training and Inferring. Training includes neural networks to raise set of binary questions, extracting knowledge blocks, classifying knowledge and eventually labelling knowledge. Inferring phase includes the conclusion and label the new obscured knowledge victimization their previous training knowledge.

There are many types of neural networks. Convolutional neural network: A Convolutional Neural Network (CNN) is a deep learning technique that can absorb an image as an input, give importance to the various objects within the image and also enables the differentiation of one from the opposite. The pre-processing needed in a very CNN is way lesser as compared to different classification algorithms. Another category is recurrent neural network (RNN) which is a kind of artificial neural network generally used in recognition of speech as well as natural language processing (NLP). They are designed in such a way so as to identify a data's sequential characteristics and for prediction of the next possible scenario it uses patterns. We will use convolutional neural network to coach our classification model. Different layers of convolutional neural network: Convolutional Layer: The convolutional

layer is that it is the basic and important building block of a CNN. The Convolution Operation's goal is to extract the high-level information options such as edges, from the input image. Activation operate (ReLU, Sigmoid): A) ReLu: The corrected linear activation operates or ReLU for brief may be a piecewise linear operate which will output the input directly if it's positive, otherwise, it'll output zero. B) Sigmoid: the most reason why we tend to use sigmoid operate is as a result of it exists in the range of (0 to 1). Hence, this is majorly used for models wherever there is a need to predict the chance as an output. Pooling Layer: The major use of the pooling layer is to scale back the quantity of parameters. of the tensor input and so helps scale back overfitting. Fully connected layer (Flatten, Dense): Flatten is employed to flatten the input. Dense layer is that the regular deeply connected neural network layer. Dense layer will the below operation on the input and come the output. In our custom model we have performed data augmentation that helps to get a greater amount of required data in the dataset. It will be connected directly to the method in which these neural networks tend to learn. Applications of Deep learning in other domains are Self Driving Cars, Entertainment, Visual Recognition, Natural Language process, Adding sounds to silent movies.

2. RELATED WORK

Styles Being reviewed a few articles and surveys, where one of the survey done [1,3]. This research published on 25th January 2021 had reviewed and critically assesses the reports and preprints published between the month of March and May 2020 for the diagnosis of COVID-19 via chest X-ray images using various deep learning architectures. Similarly, another survey done by [4] in 2020 show contribution of their work in proposing a novel deep neural network based model for detection of COVID-19 virus from chest x-ray images and built an automated tool that can guide as a forefront of the analysis. In the month of April 2020 have proposed a deep learning based model to detect and classify COVID-19 virus from chest X-ray [2] and [5]. The developed system gave an accuracy of 87.02% [3]. A limitation of their study was the limited number of X-ray images. A recent research done by [6] on 21st March 2021, proposed a model that achieved a classification accuracy of 91.62% [8,9]. A fact that has to be taken into consideration is it results a sensitivity of around 95% for COVID positive cases out of 100 corona virus positive patients, by our proposed model more than 95 patients can be correctly diagnosed [10-12].

3. PROBLEM STATEMENT

The covid-19 is a major disease issue where an extensive number of people have lost their lives over the year. Over the span of decades, numerous kinds of diseases and viruses have affected the world, but these caused the effect for only a few days or months. Several analysis and theories came into a picture which include plasma therapy, X-ray images and several more, but the most accurate solution to the disease is still uncertain. The day to day rise in cases of COVID patients across the globe and the scarcity in the availability of detection kits has posed a great difficulty in identifying if the disease is present or not. So, at this time, there is a sharpe increase to look for alternative methods. The coronavirus disease first appeared as a mere infection in the throat, and suddenly people started facing difficulty in breathing. Therefore, a deep learning approach to identify covid-19 using chest x- ray images would be ideal and can assist doctors to treat the patients faster and in an efficient manner [7].

4. PROPOSED WORK AND MODEL

We have broken down our entire work divided into five parts: [13-16]

4.1 Data Selection

The original data set was retrieved from Kaggle. The data set contains chest radiographs. With the help of the data set we can identify an individual as a covid-19 patient or not.

4.2 Data preprocessing

Data Preprocessing has been done to achieve similarity in all the radiographs and improve accuracy.

Resizing: All radiographs were resized to a particulardimension 240×240 from 1900×1400.

Augmentation: In our approach we perform online augmentation. The augmentations performed are rescale shear-range, zoom-range horizontal-flip. 288 images present in the original data set underwent online augmentation.

4.3 Model creation

A custom model shall be created based on CNN. The various layers to be used are convolutional layer, activation function, pooling layer and fully connected layer.

4.4 Training the model

The model shall be trained using 85% of images from the augmented data set. Training shall be done in order to achieve maximum accuracy.

4.5 Testing the model

Finally, the model shall be tested by using the remaining 15% of images to validate the accuracy and

ensure that the model correctly estimates age with minimal error.

5. FLOWCHART

We describe our flowchart in Figure 1.

6. METHODOLOGY

To train our classification model, we'll utilize a Convolutional Neural Network (CNN). It takes an image as input, assigns value (learnable weights and biases) to various aspects/objects in the image, and can distinguish between them. CNN's tiers are as follows:

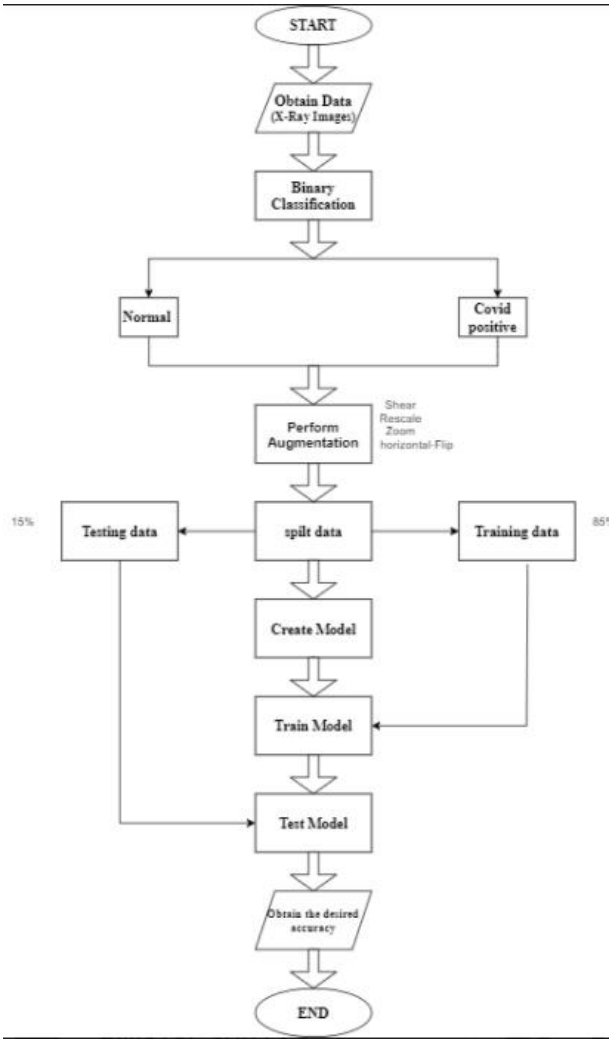

Figure 1 Flow Chart

```
Model: "sequential_1"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_6 (Conv2D)            (None, 240, 240, 32)      896
_________________________________________________________________
max_pooling2d_6 (MaxPooling2 (None, 120, 120, 32)      0
_________________________________________________________________
conv2d_7 (Conv2D)            (None, 120, 120, 32)      9248
_________________________________________________________________
max_pooling2d_7 (MaxPooling2 (None, 60, 60, 32)        0
_________________________________________________________________
conv2d_8 (Conv2D)            (None, 60, 60, 64)        18496
_________________________________________________________________
max_pooling2d_8 (MaxPooling2 (None, 30, 30, 64)        0
_________________________________________________________________
conv2d_9 (Conv2D)            (None, 30, 30, 256)       147712
_________________________________________________________________
max_pooling2d_9 (MaxPooling2 (None, 15, 15, 256)       0
_________________________________________________________________
conv2d_10 (Conv2D)           (None, 15, 15, 128)       295040
_________________________________________________________________
max_pooling2d_10 (MaxPooling (None, 7, 7, 128)         0
_________________________________________________________________
conv2d_11 (Conv2D)           (None, 7, 7, 64)          73792
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 3, 3, 64)          0
_________________________________________________________________
flatten_1 (Flatten)          (None, 576)               0
_________________________________________________________________
dense_2 (Dense)              (None, 32)                18464
_________________________________________________________________
dropout_1 (Dropout)          (None, 32)                0
_________________________________________________________________
dense_3 (Dense)              (None, 1)                 33
=================================================================
Total params: 563,681
Trainable params: 563,681
Non-trainable params: 0
```

Figure 2 Our Model

Convolutional Layer: A CNN's main building block is the convolutional layer. The parameters of the layer are made up of a series of learnable filters (or kernels) with a tiny receptive field but that stretch the entire depth of the input volume in Figure 3.

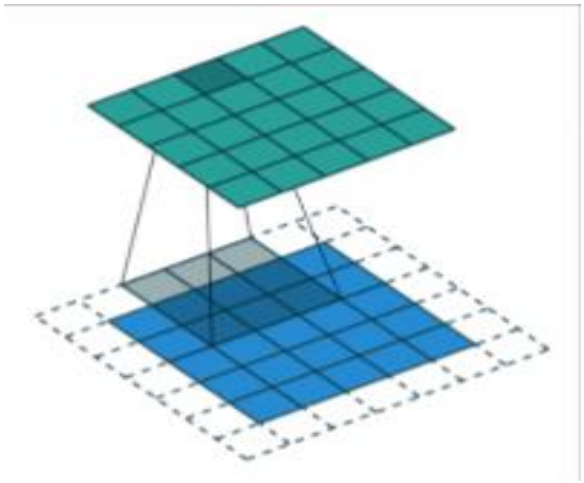

Figure 3 Extraction using Convolutional Layer

In the above diagram, a 5x5x1 image (represented in blue) is padded with 0s at the edges to create a 6x6x1 image (represented in green).[16-18]

Activation Function (ReLU): Rectified Linear Unit (ReLU): ReLU stands for Rectified Linear Unit, and it uses the non-saturated activation function: f (x) = max (0, z). Figure 4 shows how it effectively re-moves negative values from an activation map by setting them to zero.

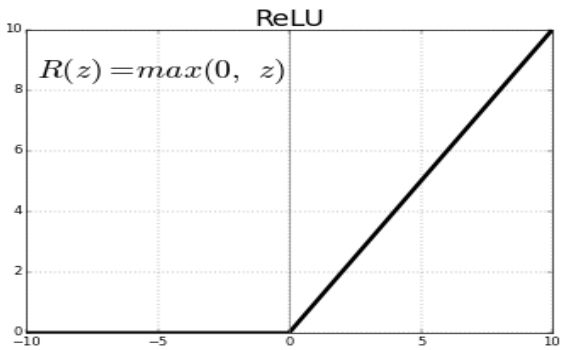

Figure 4 ReLU

In the above diagram, x axis=x and y axis=f(x)=max(0,x)

Pooling Layer: Pooling can be divided into two categories. Max Pooling and Average Pooling are the two types of pooling. In Figure 5, the main goal of a pooling layer is to reduce the number of parameters in the input tensor, which helps to reduce overfitting, extract representative features from the input tensor, and reduce computation, which helps to improve efficiency.

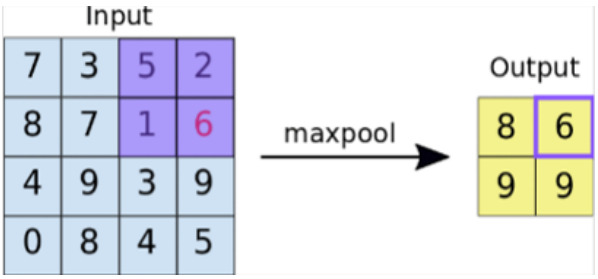

Figure 5 Pooling Layer

Flatten and Dense: The input is flattened using the flatten command. If flatten is applied to a layer with an input shape of (2,2), the layer's output shape will be (2,2). (4,1). The regular deeply linked neural network layer is the dense layer. It is the most popular and often utilised layer. The following operation is performed on the input by the dense layer, and the output is returned. In Figure 6, output=activation (dot (input, kernel) + bias)

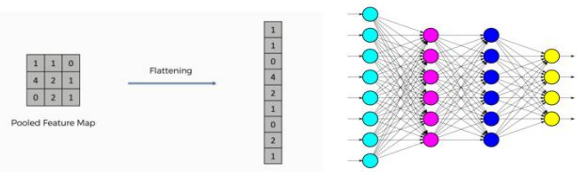

Figure 6 Flatten and Dense

In the above diagram the final outcome of the classification model is fully connected layers (nodes connected at the rightmost part of the diagram) and the final layer return the numbers of classifications desired [19-24].

7. RESULTS

Our accuracy metrics is, Mean Squared Error (MSE) is the average of squared error. It is the sum of all the square of differences between the predicted and actual values divided by the total number of instances tested. The lower the MSE, the better the accuracy. The custom model can be trained quickly and requires approximately 30 epoches in Figure 7 and Figure 8.

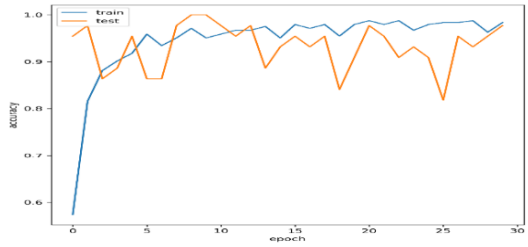

Figure 7 Accuracy

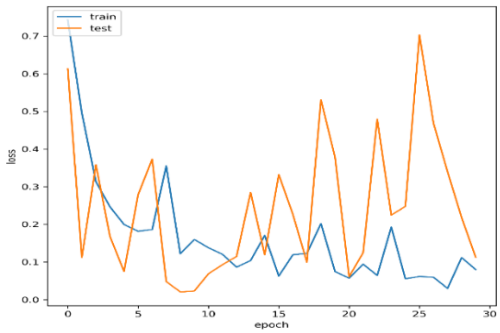

Figure 8 Loss

8. CONCLUSION AND FUTURE SCOPE

COVID-19 must be detected early and often in order to prevent the virus from spreading and to keep it under control. The goal of this study was to find COVID-19 positive patients using a simple and inexpensive method of evaluating chest x-ray pictures. In order to solve the challenge, we created a Convolutional Neural Network model (CNN) for binary classification. The proposed custom model has achieved accuracy of 97.7%. A survey found that DL methods have substantial potential in the automatic diagnosis of COVID-19 using currently available data sets. However, to evaluate the use of DL techniques, medical experts and computer scientists should collaborate closely and combine their complementary abilities. Any creative study work combined with a graphical user interface is expected to assist clinicians in detecting impacted patients using computer-aided analysis in a matter of seconds. We believe this will have a huge impact on the medical industry. Even though the publicly available data set is tiny, the results are encouraging. Our approach can be

used by radiologists to help them validate their initial screening. We intend to use larger data sets and clinical studies to further confirm our technique.

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