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CONVOLUTIONAL NEURAL NETWORK BASED COVID-19 DISEASE DETECTION FRAMEWORK USING X-RAYS

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Abstract— The COVID-19 pandemic has shown a disastrous impact on living souls. As it sustains to strike people anxiously, it has been laborious to test all at a time and it is tedious cycle. A mechanized location framework ought to be executed to hinder COVID-19 from spreading. We present a profound learning method predicated on the convolutional neural network (CNN). The dataset contains 122 COVID-19 X-Rays and 124 Normal pictures for testing. The rates of false positives of molecular tests have ranged from 2% to 37%. The trial results show that our proposed framework accomplished accuracy of 95.0%, specificity of 96.55%, sensitivity of 93.45%, and F1-score of 95.07%. The framework accomplished desired outcomes on the as of now accessible dataset, which can be additionally further developed when more COVID-19 pictures become accessible. The proposed framework can profit medicos to analyse and treat COVID-19 patients facilely.

***Index Terms* — COVID-19, Convolutional Neural Network, Chest X-rays, Deep Learning.**

1 Introduction

Coronavirus (COVID-19) is an infectious disease. The vast majority tainted with the COVID-19 infection will encounter gentle to direct respiratory ailment and recuperate without requiring exceptional treatment. It has been declared a pandemic by the World Health Organization (WHO) on 11 March 2020[1]. Older people and those with fundamental clinical issues like cardiovascular infection, diabetes, constant respiratory sickness, and malignant growth are bound to foster genuine disease [2]. The most ideal way of forestalling and dial back transmission is to be very much informed with regards to the COVID-19 infection, the sickness it causes and how it spreads. Shield yourself as well as other people from disease by cleaning up or utilizing a liquor based rub every now and again and not contacting your face. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes, so it's important that you also practice respiratory etiquette (for example, by coughing into a flexed elbow).

The number of people infected changes daily. Organizations that collect this information, including the World Health Organization (WHO) and the Centres for Disease Control and Prevention (CDC), are gathering information, and continuously learning more about this outbreak. As of this writing (05/11/2021), more than 159,000,000 people in the world have been infected. Over 3,300,000 people have died. Some 192 countries and territories on all continents (except Antarctica) have now reported cases of COVID-19. The U.S. has the highest number of cases, with more than 32,000,000 people infected and over 580,000 deaths. India has nearly 23,000,000 cases and 250,000 deaths. Brazil has more than 15,200,000 cases and 420,000 deaths. France has over 5,800,000 cases; Turkey has over 5,000,000 cases; Russia and England have over 4,400,000 cases; Italy has more than 4,100,000; Spain and Germany have over 3,500,000 cases; Argentina and Columbia have more than 3,000,000 cases; Poland and Iran have over 2,600,000 cases and Mexico has over 2,300,000 cases [3,4].

When the infection goes in respiratory beads when a contaminated individual hacks, wheezes, talks, sings, or inhales close to you (inside six feet) [2]. This is believed to be the principle way COVID-19 is spread. When the infection goes in little respiratory beads that wait noticeable all around for quite a long time to hours from a contaminated individual who is more than six feet away or has since left the space. This technique for spread is bound to happen in encased spaces with helpless ventilation. From close contact (contacting, shaking hands) with a tainted individual. By contacting surfaces that the infection has arrived on, then, at that point, contacting your eyes, mouth, or nose prior to cleaning up. (Not idea to spread effectively by this strategy). Coronavirus enters your body through your mouth, nose or eyes (straightforwardly from the airborne drops or from move of the infection from your hands to your face). The infection goes to

the rear of your nasal sections and mucous film toward the rear of your throat. It joins to cells there, starts to duplicate and moves into lung tissue. From that point, the infection can spread to other body tissues. States, wellbeing organizations, analysts and medical services suppliers are on the whole cooperating to foster arrangements and methods to restrict the spread of this infection both universally and from one person to another.

Specialists are as yet finding out with regards to COVID-19. What IS known is that individuals contaminated with COVID-19 can spread the infection to others prior to encountering side effects themselves (while individuals are still "asymptomatic"). When you do have side effects, the CDC says you are presently not infectious 10 days after your manifestations started.
Until everything about COVID-19 is fully understood, the best advice from healthcare providers to remain safe is to:

- Stay six feet away from others whenever possible.
- Wear a cloth mask that covers your mouth and nose when around others.
- Wash your hands often. If soap is not available, use a hand sanitizer that contains at least 60% alcohol.
- Avoid crowded indoor spaces. Bring in outdoor air as much as possible.
- Stay self-isolated at home if you are feeling ill with symptoms that could be COVID-19 or have a positive test for COVID-19.
- Clean and disinfect frequently touched surfaces.

The greatest level screening procedure used for testing the COVID-19 patients is the Reverse Transcription Polymerase Chain Response (RT-PCR) test on respiratory. This technique is the most by and large used procedure for testing for COVID-19 distinguishing proof anyway is a manual, confounded, tenacious and time-consuming process with an inspiration pace of just 63 % [5]. The other analysis apparatuses of COVID-19 can be clinical indications examination, epidemiological history, and positive radiographic pictures (registered tomography (CT)/Chest radiograph (CXR)) just as sure pathogenic testing.

The symptoms of COVID-19 resembling viral pneumonia can on occasion prompt wrong assurance in the current situation, where clinical facilities are over-weight and working relentlessly. Thusly, erroneous determination can incite a non-COVID viral Pneumonia being dishonestly set apart as incredibly dubious of having COVID-19 and as such conceding in treatment with coming about expenses, effort and risk of show to positive COVID-19 patients. Right now numerous biomedical confusions (e.g., mind growth discovery, bosom malignancy recognition, and so on) are utilizing Artificial Intelligence (AI) based arrangements. Profound learning procedures can uncover picture highlights, which are not clear in the first pictures. Specifically, Convolutional Neural Network (CNN) has been exhibited incredibly supportive in incorporate extraction and learning and hence generally embraced by the examination local area [6]. CNN was used to further develop picture quality in low-light pictures from a high-speed video endoscopy and was furthermore applied to recognize the possibility of aspiratory handles through CT pictures, the finish of paediatric pneumonia through chest X-ray pictures, robotized checking of polyps during colonoscopy accounts, cryptoscopic picture affirmation extraction from accounts. AI strategies on chest X-Rays are getting prominence as they can be handily used with low-cost imaging methods and there is a bounty of information accessible for preparing distinctive machine-learning models. Idea of move learning in profound learning system was used by Vikash et al. [7] for the acknowledgment of pneumonia using pre-trained ImageNet models [8] and their troupes. A redid VGG16 model was utilized by Xianghong et al. [9] for lung locales recognizable proof and different kinds of pneumonia portrayal. Wang et al. [10] utilized an enormous dataset and Ronneburger et al. [11] utilized picture expansion alongside CNN to give indications of progress results by means of getting ready on little plan of pictures. Rajpurkar et al. [12] reported a 121-layer CNN on chest X-rays to distinguish 14 particular pathologies, including pneumonia using a group of various organizations. A pre-trained DenseNet-121 and extraction methods were utilized in the exact recognizable proof of 14 thoracic sicknesses in [13]. Sundaram et al. [14] utilized AlexNet and GoogLeNet with picture expansion to acquire an Area Under the Curve (AUC) of 0.95 in pneumonia disclosure. The trial of COVID-19 is at present a troublesome errand due to unavailability of conclusion framework all over the place, which is causing alarm. Because of the restricted accessibility of COVID-19 testing units, we need to rely upon various assurance measures. Since COVID-19 attacks the epithelial cells that line our respiratory lot, we can use X-beams to research the strength of a patient's lungs. The clinical professional often utilizes X-beam pictures to break down pneumonia, lung irritation, abscesses, and expanded lymph hubs. What's more, practically in all medical clinics have X-beam imaging machines, it very well may be feasible to utilize Xray's to test for COVID-19 without the devoted test packs. Once more, a disadvantage is that X-beam assessment requires a radiology expert and takes tremendous time, which is significant when individuals are debilitated all throughout the planet. In this manner, fostering a computerized examination framework is crucial for save clinical expert's important time. As of late, a few gatherings have portrayed deep-learning based COVID-19 pneumonia discovery methods [15-16]. Shuai et al. [16] utilized profound learning procedures on CT pictures to screen COVID-19 patients with a precision, particularity and affectability of 89.5%, 88% and 87% separately. Linda et al. [15] introduced a DCNN, called COVID-Net for the location of COVID-19 cases from the chest X-ray pictures with a precision of 83.5%. Ayrton [17] utilized a little dataset of 339 pictures for preparing and testing utilizing ResNet50 based profound exchange learning method and detailed the approval precision of 96.2%. In this review, we have fostered a programmed identification of COVID-19 utilizing a DCNN based Inception V3 model and Chest X-beam pictures. This paper proposes profound learning way to deal with anticipate the COVID-19.

In this paper we utilized Deep Learning to distinguish COVID-19 infection. For this paper we utilized TensorFlow critically Keras to prepare to characterize ordinary and COVID-19 contaminated pictures and accomplished 95% exactness.

2 Problem Formulation

To control the COVID-19 spreading, many tests should be done to detach patients infected with COVID-19. The test types we are having today are tedious and frequently brings about adverse results. Thus, there is a urgent requirement for an original strategy. We used the machine learning classification technique to classify the Chest X-ray images. We done numerous numbers of iterations to increase accuracy. In this cycle we utilized Keras library of TensorFlow. Keras is an open-source programming library that gives a Python interface to counterfeit neural organizations. Keras goes about as an interface for the TensorFlow library [18].

3 Materials and Methodology

The convolutional neural network (CNN) is a class of deep learning neural networks. They are classification modes mostly used to analyse visual imagery. These models are working hard behind the scenes in everything from healthcare to security. The details of materials and methodology are explained in the following sections.

3.1 Materials

The X-Ray data set and tools are the major material used in this work; the details of these materials are explained in this section.

3.1.1 X-Ray Dataset

For this study we collected 122 COVID infected X-rays and 124 normal patient X-rays for training the classifier. The Width and Height of image size varies from 650 px to 882 px. The image is minimized into Regular shape so that it can be used for classification.

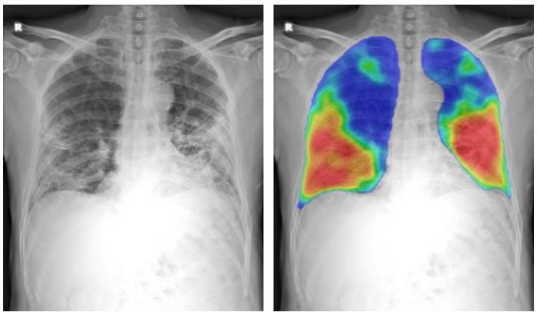


figure 1. chest radiography images of covid-19

The above mentioned X-rays are of COVID-19 infected person.The left image is the generic X-ray and the right image is X-ray spotted with effected area. From above image we could say that person is effected with 52% Covid.

3.2.2 Tools

One of the major tool is used in this work is Keras, it is an API designed for human beings, not machines. Keras follows best practices for reducing cognitive load, it offers consistent, and simple APIs. It minimizes the number of user actions required for common use cases, and it provides clear and actionable error messages.

3.2.2.1 Keras

Keras is a high-level neural networks API, written in Python, and can run on top of TensorFlow, CNTK, or Theano. It was developed with a focus on enabling fast experimentation.

3.2.2.1 TensorFlow

TensorFlow is a free and open software for Machine Learning and Artificial Intelligence. It can be used across a range of tasks but has a particular focus on training and inference of deep Neural Networks.

3.3 Methodology

The methodology includes four major steps, model training, CNN classifier model creation, model testing, and model evaluation. The detailed methodology of the CNN base COVID-19 disease detection using X-Ray is shown in figure 2.

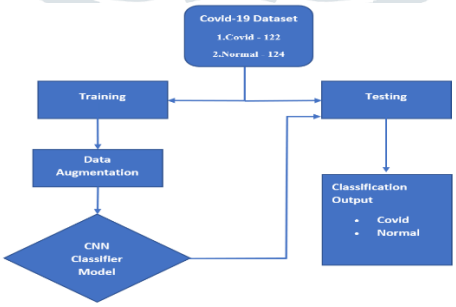


figure 2. the methodology of the cnn base covid-19 disease detection using x-ray

3.3.1 Model Training

In this phase, the model is trained using training data set and expected output. The model.fit_generator function is used to train the model. The arguments to this function are training data, steps per epoch, total epochs, validation data, and total validation steps.

3.3.2 Creation of CNN Model

Model creation begins with instantiating the object. The object is instantiated with sequential class. The layers Conv2D, MaxPool2D, Dropout, Flatten, and Dense are used to create the CNN model. The germane activation functions (**'relu'** and **'sigmoid')** are also used to create this model. The total params is 7,503,105, trainable params is 7,503,105, and non-trainable params is zero. The detailed summary of the model as shown in the table 1.

Layer (type)	*Output Shape*	*Param #*
conv2d (Conv2D)	(None, 254, 254, 32)	896
conv2d_1 (Conv2D)	(None, 252, 252, 64)	18496
max_pooling2d (MaxPooling2D)	(None, 126, 126, 64)	0
dropout (Dropout)	(None, 126, 126, 64)	0
conv2d_2 (Conv2D)	(None, 124, 124, 64)	36928
max_pooling2d_1 (MaxPooling2)	(None, 62, 62, 64)	0
dropout_1 (Dropout)	(None, 62, 62, 64)	0
conv2d_3 (Conv2D)	(None, 60, 60, 128)	73856
max_pooling2d_2 (MaxPooling2)	(None, 30, 30, 128)	0
dropout_2 (Dropout)	(None, 30, 30, 128)	0
flatten (Flatten)	(None, 115200)	0
dense (Dense)	(None, 64)	7372864
dropout_3 (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 1)	65

table 1. the summary of the cnn model.

Algorithm-1 **ModelCreation**(X,n)
Input: An array X of X-ray Images, An array of class Indices. **Output**: Class Indices either Covid-19 disease or Normal
1.Declare a train_data variable that contains Training Data. 2.Intialiase the steps_per_epoch to 8. 3.Intialiase variable epochs to 100. 4.Copy the test data into validation_data. 5.Finally allocate validation steps as 2.

The algorithm 1 shows the model creation, here model.fit_generator function is used to classify whether the input image is COVID-19 disease infected or normal.

3.3.3 Model Testing

In this phase, the model is used to detect the other image which hasn't seen by model before. By this phase we can get the accuracy of Model. Model can be saved by model.save ("name_of_file.h5").

3.3.4 Model Evaluation

At last, the saved model can be used in real life for detection of COVID-19 through X-rays. This phase is called as Model Evaluation. This means that the model can be used to evaluate new data.

4 Results and Discussion

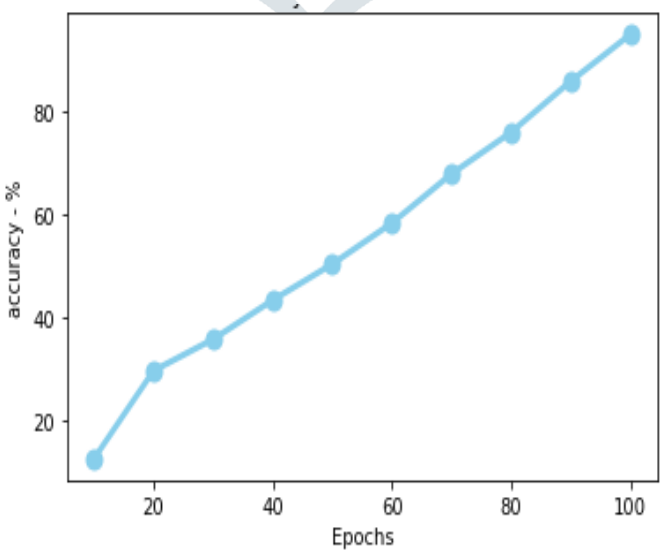
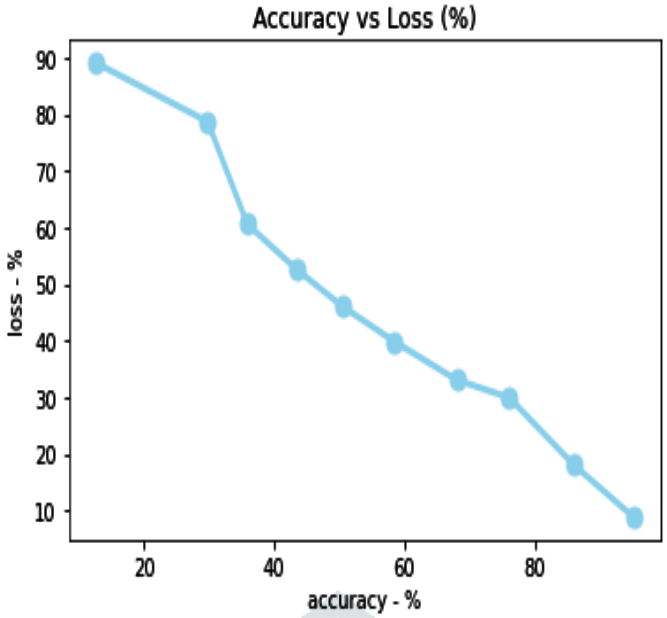


figure 3. dependence of the evaluation accuracy on the number of epochs.



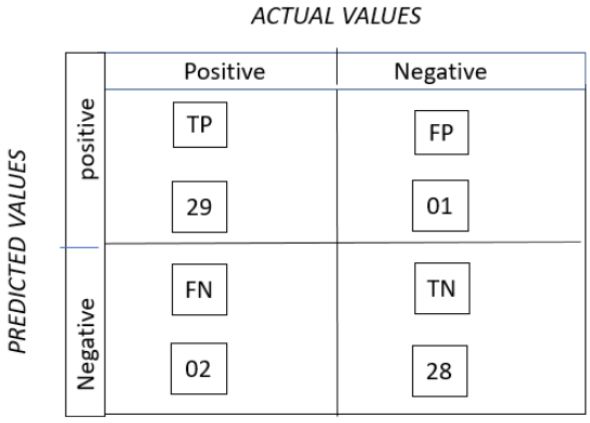


figure 4. confusion matrix for validation data set

Formulas for the Confusion matrix: -

Confusion Matrix is a method often used to describe the performance of **Classification** Model("Classifier").

Basic terms are: -

True Positives (TP): These are cases in which we predicted yes (they have the disease), and they do have the disease.

True Negatives (TN): We predicted no, and they don't have the disease.

False Positives (FP): We predicted yes, but they don't have the disease. (Also known as a "Type I error.")

False Negatives (FN): We predicted no, but they actually do have the disease. (Also known as a "Type II error.")

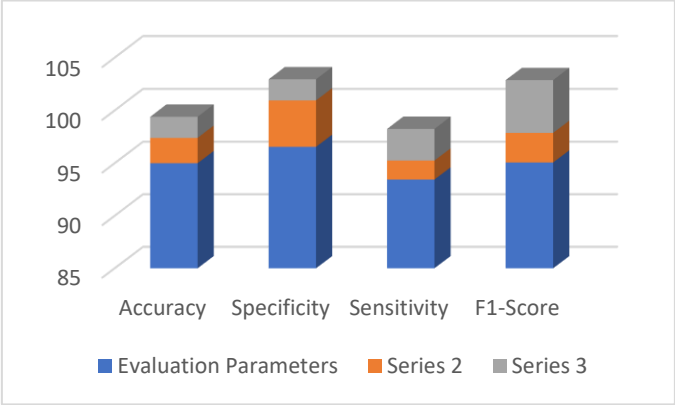


figure 5. evaluation parameters

1.Accuracy: - It is a metric that summarizes the performance of a classification model as the number of correct predictions divided by the total number of predictions.

$$Acc = \frac{TP + TN}{P + N} \quad (1)$$

2.Sensitivity (True Positive Rate): -It refers to the proportion of those who received a positive result on this test out of those who have the condition.

$$TPR = \frac{TP}{TP + FN} \quad (2)$$

3.Specificity (True Negative Rate): - It refers to the proportion of those who received a negative result on this test out of those who do not actually have the condition.

$$TNR = \frac{TN}{TN + FP} \quad (3)$$

4.F1 Score: -It is needed when you want to seek a balance between Precision and Recall.F1 Score might be a better measure to use if we need to seek a balance between Precision and Recall AND there is an uneven class distribution.

$$Acc = 2 \times \frac{Precision \times Recall}{Precision + Recall} \quad (4)$$

EVALUTION MEASURES	VALUES
Accuracy	95.0%
Specificity	96.55%
Sensitivity	93.5%
F1-score	95.07%

table: evaluation measures

5 Conclusion and Future Work

In this work, we introduced novel method for testing COVID-19 utilizing chest radiographical X-beams. By utilizing this method, we can get most extreme outcomes clearly and in a flash. In this way, giving a serious option in contrast to standard tests like RDT, TrueNat and so forth

6 Future Work and Extensions

CNN characterization can be utilized to settle numerous different assignments like Using CNNs to Classify Hand-composed Digits on MNIST Dataset, Identifying Images from the CIFAR-10 Dataset utilizing CNNs, Categorizing the Images of ImageNet utilizing CNNs, and so on as we are seeing the delta variation of COVID-19 at this point. We might want to prepare one model utilizing most recent informational collection and anticipating planning a **System** that accepts X-Rays as information and foresee COVID-19. We are attempting to expand accuracy by including Inception V3 for preparing a model.

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