A Predictive Framework for Detection of Corona Virus based on Transfer Learning Approach

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Abstract

Early identification of COVID -19 has a substantial influence on reducing COVID -19 transmission at a faster rate and is the need of the moment. AI diagnostics utilizing deep learning models trained on X-ray pictures of COVID-infected and uninfected persons is a viable new technique for early prediction and diagnosis of COVID-infected patients. This study presents a technique that can be used to automatically identify the corona virus from machine-made chest X-ray images in less than five minutes. For this we use a collection of chest X-ray images of pneumonia, COVID 19 disease, and healthy infected patients. Transfer Learning is used because it has the advantage of reducing training times for a neural network model. The result shows 99.49% accuracy in predicting Corona virus from an X-ray of a suspect patient using the VGG Transfer Learning framework.

Keywords: Covid Detection, Pneumonia, X-ray, Convolution Neural Networks (CNN), Transfer Learning.

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INTRODUCTION

COVID-19 is an infectious illness caused by a recently found coronavirus that poses a major risk to public health and the economy of the country. This can result in respiratory infections ranging from the ordinary cold to more serious conditions like MERS and SARS. The epidemic began in Wuhan, China, in December 2019. The disease is very contagious, and there are presently no vaccinations or treatments available to prevent or treat it. Quarantine is the only way to prevent the sickness from spreading.

Early diagnosis is important to control its spread. Headache, Sore throat, cough, and mild respiratory are the Syndromes of the disease that may turn into pneumonia. It is presently a worldwide epidemic that has spread to various countries. The number of instances is increasing all across the world. Every day, thousands of individuals are diagnosed with coronavirus, and the mortality toll continues to rise. One approach to find out is to use PCR testing. Find a specific gene for the coronavirus and repeat it for easy reference. We may use distorted written PCR tests as well as these PCR tests. This is achieved by taking nasal samples. These test kits are only available for a limited amount, which is not enough in the current situation. Due to the lack of a RT-PCR test kit, additional methods are needed to detect and prioritize COVID-19. Otherwise, the virus could easily spread, increasing the number of patients. In addition to these clinical trials, it helps to support computer technology as an artificial intelligence, as it has the potential to play an important role. AI has been frequently conducted to explore novel combinations in the search for a CORONA solution. AI is exploited by man researchers to find new therapies, and some computer scientists are focusing on diagnosing people with the virus by examining medical imaging such as X-rays and scans of computed topography [3]. Because doctors routinely use X-rays to diagnose pneumonia and other conditions, X-ray detection of Covid can play an important role in coronary screening.

Covid testing level can be increased by exploiting X-ray testing as the initial test, and if the prediction of AI is reliable then the patient can be sent to take medical tests. A method used for machine learning which focuses on keeping the information learned by resolving one difficulty which is known as Transfer learning and using it to other difficulties. For the need of studying the transmission, a set of chest images are considered for Corona patients and the general public was used. Section II summarizes some of the latest Covid prediction research based on AI and Deep Learning (DL). Section III describes the test results and the methods applied based on VGG16 model in the Covid prediction.

MATERIALS AND METHODS

Many researchers have been working on the virus since the virus spread, finding different ways to detect and treat covid-19. The idea of considering chest images in predicting Corona virus stems from early attempts to use deep neural networks to diagnose pneumonia using chest x-rays [4]. It is also important to have a strong database containing certified X-ray images of covid19 patients. Automatic algorithms were developed to diagnose and classify pneumonia on the basis of images of chest [7].Models built for CNN are of 3 types (ResNet50, InceptionV3 and Inception-ResNetV2) used to diagnose coronavirus and pneumonia in ill caused patients based on radiological analysis of chest [8]. Therefore, the work performed may contain diagnostic ambiguity. They analyzed how NCBs with pull weights can balance this ambiguity [9]. For covid-19 transfer reading as additional way to construct a typical structure initially, minimizes the performance parameters through learning models [10]. We proposed to use VGG, a transfer study model, to predict covid-19 X-rays in this study. Transfer learning through convolutional neural networks has also been used in the past [11]. For the database, the CNN is exploited with TL environments with networks like Inception. The built in model carried out based on VGG16 currently accessible. Following segment provides overview of VGG16 to predict COVID on X-rays of patients who may be COVID.

For detecting the corona syndrome in chest, more X-ray images of chest are required. Our model was trained in certified covid-19 infections and other common X-rays to predict Covid, as well as pneumonia, pneumothorax, and tuberculosis (TB), so that it could isolate and predict all five different conditions. There is a collection of these databases online [5] [6]. We used a small database of 1824 images from an accessible database [12] to train our model, which included Covid and regular radiographs. Sample radiograph shows the samples of Corona persistent chest with a typical article are shown in Fig. 1. Then, with multiple classifications and predictions, we compiled a database of 2476 radiographs of pneumonia, pneumothorax, tuberculosis, covid-19 and general patients from various sources [6].

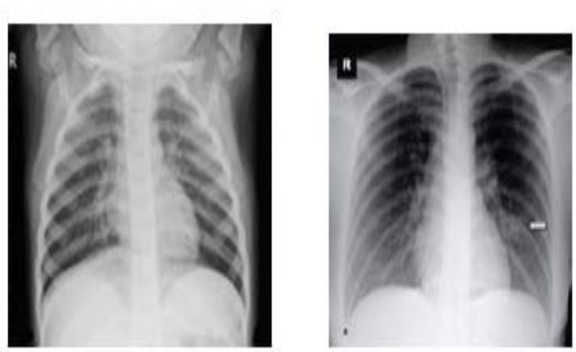


Fig. 1. Detecting Corona infection through X-rays

1. Transfer Learning Approach

The innovative exemplary technique uses single or multiple levels of training model. Reduces neural network training time for hyper parameter tuning optimization. The network has been trained based on transfer learning model which stabilizes only certain layers of the model. VGG, Google Net i.e., Inception v1 or v3 and Residual Network Transfer are the three most common methods of learning (ResNet50). Keras gives you access to a wide range of pre-trained models. The datasets are trained with Convulsive net before they are applied for analyzing novel image sets which build efficiency in learning transfer. We use a learning transfer model trained on the Imagenet dataset, which has 70,000 images in 10 different classifications. Transfer learning techniques are applied for exploring Convulsive net for performance analysis in medical applications. The thrust transfer VGG model is used and is presented in figure 2.

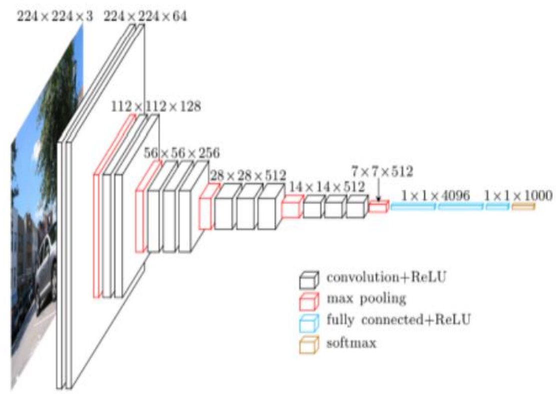


Fig.2. VGG Architecture

VGG 16 contains 16 weight layers with 13 flexible layers of 3 X 3 filter sizes and completely integrated layers, as well as fully integrated layers. AlexNet is similar to the fully integrated VGG-16 layer architecture. The convolutional stride and padding layers have all been set to 1 pixel. Each convolutional layer is separated into five groups, followed by a mass consolidation layer. All VGG hidden layers use ReLU. Local Response practice is rarely used by VGG (LRN). First, the top parameter value of 'False' is applied to the base model, which is the pre-trained VGG16 model.

As a result, the base model is then referred as the head model, and is now modified to meet the needs of our model. The head model now has new FC layers. The following algorithm outlines the entire implementation process. Deep Architecture helped predict the result with 99.49 percent accuracy, which is higher than the initial model. Our proposed model implementation is shown in Figure 3.

METHODOLOGY

This section presents a proposed methodology for classifying radiographs as healthy patients or patients affected by COVID 19. Firstly, explanation about the image dataset used in this study. And then explanation regarding the process of feature extraction based on transfer learning theory. After there would be the classification techniques used and the steps in their training process. Lastly, metrics used to evaluate results. The methodology for detecting the COVID-19 detection from chest X-Ray images is mainly divided into the following steps. The below fig 3 shows the methodology and workflow involved in detecting the Covid 19 from chest x-ray images and it gives the detailed explanation of each step in further.

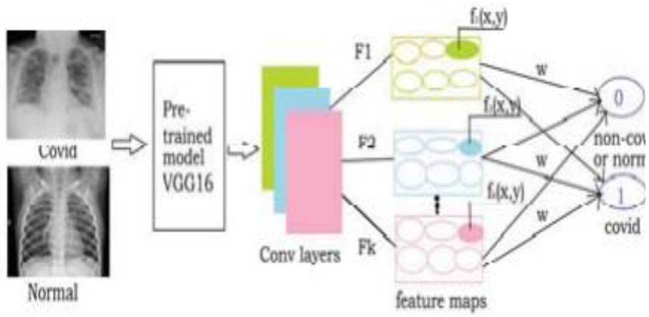


Fig. 3. Flow diagram of proposed model

1. Algorithm

- Initial step is to upload a database which consists of 2476 five-class images and 1824 two-class images.
- The database images needed to be minimized to that size of 224 × 224 input images.
- A latest completely integrated layer header is made which consists of POOL => FC = SOFTMAX layers and linked over VGG16 because this model is required by a previously trained image by parting out header of FC layer.
- At last, the convolution weights of VGG16 are stopped to train the FC layer head shown in fig 4.
- A first-hand chest image is taken for checking if the patient is pretentious with Corona infection or other illnesses like pneumonia, pneumothorax, or tuberculosis, may be expected.

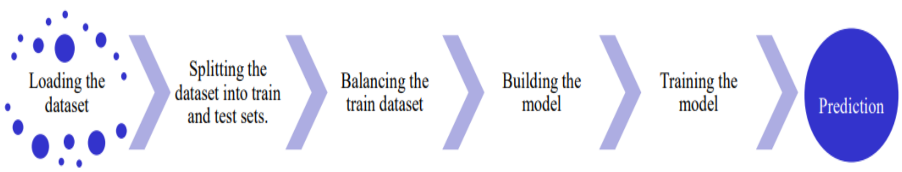


Fig 4. Overall framework for detecting the COVID-19

EXPERIMENTAL RESULTS

The prediction of Corona infection is well suited with VGG model. In this case, we have done a few tests. The tests and findings are described in the sections. Our model received chest x-rays as implants. In our model, this data is divided into 8:2 ratio, with 80% going to model training and 20% going to model validation. All data set images are also scaled down to the default image size (224,224).

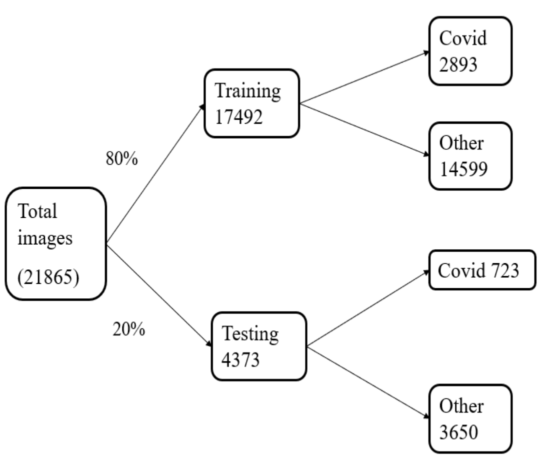


Fig 5. Splitting of training and testing sets

Figure 5 shows the VGG process for removing elements from images. To create a high-performance model, the hyper parameters are tweaked. Adjustments were made to alter the rate of learning with other parameters. The optimizer function takes the learning rate as an argument. Working with many optimizers and loss functions had little effect on model performance. So, Adam is used as the optimizer in the construction of entire architecture. The samples number are transferred by using net which meant as batch size, while Yugo refers to how often the model will be applied to the training data. Regularization strategy i.e., dropout in which certain unsystematic nets are discarded at training. Table 1 shows that the changing parametric estimators shake the overall progress of the architecture during the training of 66-image dataset. Then, after training across the entire dataset using settings such as 30 epochs, 5 batch sizes, 1e-3 learning rate, 0.2 as test size and 20 rotation range for the accuracy of two classes was 99.49 percent and 98 percent accuracy for multiclass with 5 classes shown in fig 6.

An N x N matrix called a confusion matrix is used to assess the effectiveness of a classification model, where N is the total number of target classes. In the matrix, the actual goal values are contrasted with those that the machine learning model anticipated. Sklearn. Metrics library's confusion matrix is imported shown in table 1.

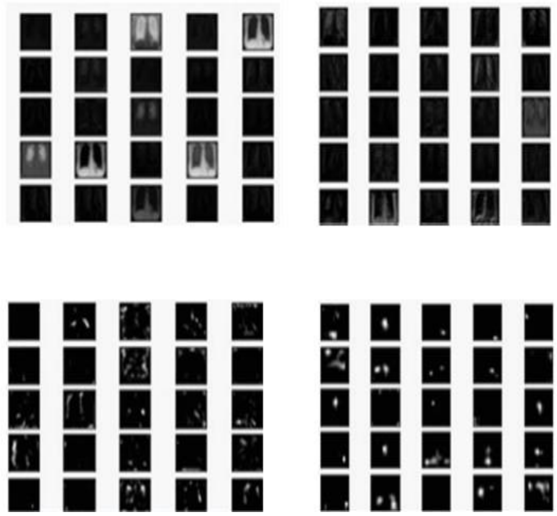


Fig. 6. Extraction of Features with chest Images

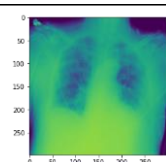
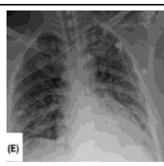
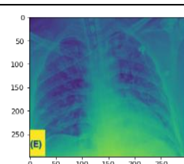
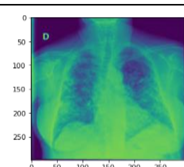
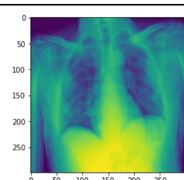
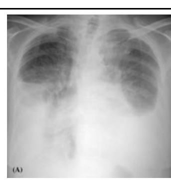
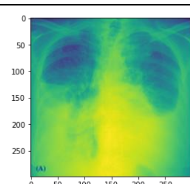
The following 2 × 2 matrix represents a binary classification issue and has 4 values: Positive or negative values can be assigned to the target variable. The target variable's real values are shown in the columns. The target variable's projected values are shown in the rows of table 2.

Table 1. Confusion Matrix (2x2)

Cases	Non Covid	Covid
Non Covid	3366	284
Covid	86	637

A common metric for evaluating the effectiveness of a classification model is the AUC-ROC. The capacity of a model to distinguish across classes is readily identified and described by the AUC-ROC statistic. The AUC serves as the evaluation criteria, with a higher AUC indicating a better model. The relationship and trade-off between sensitivity and specificity for each potential cut-off for a test or collection of tests are frequently illustrated using AUC-ROC curves. The region below the ROC curve shows how valuable it is to use the test to address the underlying topic. AUC-ROC curves are frequently used to assess performance for classification tasks at various threshold settings shown in table 3.

Table 2: Transformation of image at different levels

Input Image	Output Image	Remarks
		COVID +ve
		COVID +ve
		COVID +ve
		COVID +ve
		COVID +ve

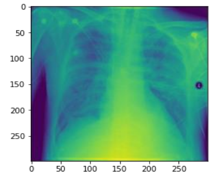
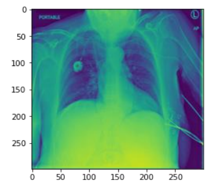
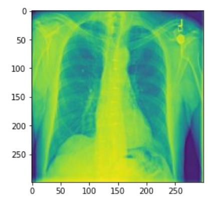
		COVID -ve
		COVID -ve
		COVID -ve

Table 3: Comparison of different models with different parameters

Learning rate	Batch size	epochs	accuracy	f1score	Drop Out
0.001	10	75	0.94	0.805	0.2
0.001	10	30	0.87	0.68	0.5
0.001	32	30	0.87	0.79	0.1
0.002	32	100	0.92	0.77	0.1
0.0005	64	50	0.91	0.75	0.1
0.0005	128	50	0.92	0.81	0.2
0.0005	64	100	0.92	0.817	0.2
0.0007	64	100	0.93	0.84	0.1
0.0009	64	100	0.93	0.77	0.1
0.0027	64	100	0.88	0.77	0.2
0.001	25	75	0.93	0.81	0.1
0.002	25	75	0.87	0.78	0.1
0.001	16	75	0.93	0.77	0.05
0.001	16	75	0.92	0.78	0.05
0.001	16	75	0.92	0.8	0.05

A common metric for evaluating the effectiveness of a classification model is the AUC-ROC. The capacity of a model to distinguish across classes is readily identified and described by the AUC-ROC statistic

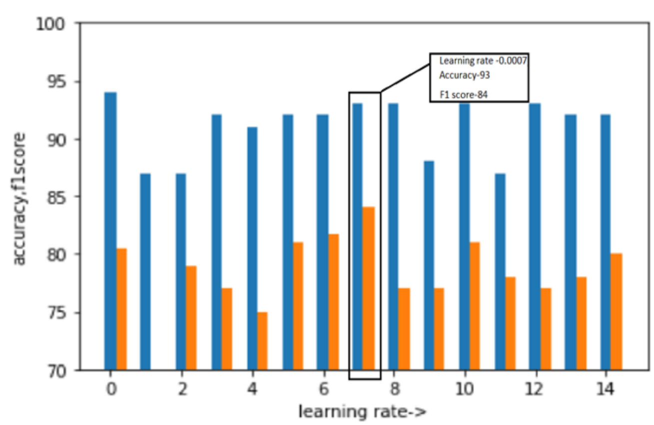


Fig 7. ROC Curve

The above parameters decides the model performance. Through these parameters one can able to decide the best combination of parameters. Hence the model attains accuracy of 93% and f1 score of 84% shown in fig 7.

Conclusion

In this study, x-ray images were trained using Convolution Neural Networks and the Visual Geometric Group model to predict the novel Covid-19 illness. We were able to detect the Covid-19 virus with % reliability using chest X-rays, as well as 98 percent for other classes including pneumonia and Covid. This work supports the widespread usage of AI, particularly in TL, that is used to predict health outcomes. This approach may be implemented in more advanced and real-time scenarios, such as exploiting the Internet of Things to obtain quick X-rays of suspicious Covid-19 victims and forecast outcomes in less time. The Visual Geometric Group model, which we created, may also be employed in various transfer learning approaches. Our key goal for the future is to build this model on a larger dataset so which we can properly train it and enhance the accuracy, as additional data helps the model to perform better on hidden data in machine learning. It may also be used to forecast whether or not an individual will live. We're working on it as well. However, we anticipate that this endeavor will progress and that it will produce information that will aid in the medical research of Covid-19.

References

K. Roosa, Y. Lee, R. Luo, A. Kirpich, R. Rothenberg, J. M. Hyman, P. Yan, and G. Chowell, “Real-time forecasts of the COVID-19 epidemic in china from February 5th to February 24th, 2020,” Infect. Dis. Model., vol. 5, pp. 256–263, Feb. 2020.

Shiwali Yadav, Rakesh Kumar, “RT-PCR Result Based Covid-19 Prediction Using Voting Classification Approach”, 2021 2nd International Conference on Smart Electronics and Communication (ICOSEC), 15 November 2021.

Ohata, Elene Firmeza, Gabriel Maia Bezerra, Joao Victor Souza das Chagas, Aloisio Vieira Lira Neto, Adriano Bessa Albuquerque, Victor Hugo C. de Albuquerque, and Pedro Pedrosa Reboucas Filho, "Automatic detection of COVID-19 infection using chest X-ray images through transfer learning.", IEEE/CAA Journal of Automatica Sinica, VOL. 8, NO. 1, January 2021, pp. 239-248.

Jain, Rachna, Meenu Gupta, Kunal Jain, and Sandeep Kang, "Deep learning based prediction of COVID-19 virus using chest X-Ray.", Journal of Interdisciplinary Mathematics, January 2021, pp. 1-19.

Maghari, Ashraf Yunis, "COVID-19 Detection in X-ray Images using CNN Algorithm.", 2020 International Conference on Promising Electronic Technologies (ICPET), IEEE, December 2020, pp. 5-9.

Haritha, D., Ch Praneeth, and M. Krishna Pranathi, "Covid Prediction from X-ray Images", 2020 5th International Conference on Computing, Communication and Security (ICCCS), IEEE, October 2020, pp. 1-5.

Haritha, D., N. Swaroop, and M. Mounika, "Prediction of COVID-19 Cases Using CNN with X-rays.", 2020 5th International Conference on Computing, Communication and Security (ICCCS), IEEE, October 2020, pp. 1-6.

Bekhet, Saddam, M. Hassaballah, Mourad A. Kenk, and Mohamed Abdel Hameed, "An Artificial Intelligence Based Technique for COVID-19 Diagnosis from Chest X-Ray.", 2020 2nd Novel Intelligent and Leading Emerging Sciences Conference (NILES), IEEE, October 2020, pp. 191-195.

Karhan, Zehra, and A. K. A. L. Fuat, "Covid-19 Classification Using Deep Learning in Chest X-Ray Images", 2020 Medical Technologies Congress (TIPTEKNO), IEEE, November 2020, pp. 1- 4.

Jabber, Bhukya, Jeevan Lingampalli, Cmak Zeelan Basha, and Azmira Krishna, "Detection of Covid-19 Patients using Chest X-ray images with Convolution Neural Network and Mobile Net.", 2020 3rd International Conference on Intelligent Sustainable Systems (ICISS), IEEE, December 2020, pp. 1032-1035.

D. S. Kermany, M. Goldbaum, W. J. Cai, C. C. S. Valentim, H. Y.Liang, S. L. Baxter, A. McKeown, G. Yang, X. K. Wu, F. B. Yan, J.Dong, M. K. Prasadha, J. Pei, M. Y. L. Ting, J. Zhu, C. Li, S. Hewett, J.Dong, I. Ziyar, A. Shi, R. Z. Zhang, L. H Zheng, R. Hou, W. Shi, X. Fu,Y. O. Duan, V. A. N. Huu, C. Wen, E. D. Zhang, C. L. Zhang, O. L. Li,X. B. Wang, M. A. Singer, X. D. Sun, J. Xu, A. Tafreshi, M. A. Lewis,H. M. Xia, and K. Zhang, “Identifying medical diagnoses and treatable diseases by image-based deep learning,”2018, Cell, vol.172, no. 5, pp.1122–1131.E9, Feb. 1122.

Vikash Chouhan, Sanjay Kumar Singh, Aditya Khamparia, Deepak Gupta,Prayag Tiwari,Catarina Moreira, Robertas Damaševiˇcius and Victor Hugo C. de Albuquerque “A Novel Transfer Learning Based Approach for Pneumonia Detection in Chest X-ray Images”,2020, Appl. Sci. 2020, 10, 559.

Random Oversampling [Online] Available: https://dataaspirant.com/handle-imbalanced-data-machine-learning/

Training and validation parameters [Online] Available: https://www.analyticsvidhya.com/blog/2020/06/auc-roc-curve-machine-learning/

COVID-19 Coronavirus Pandemic. [Online]. Available: https://www. worldometers.info/coronavirus/

Swab collection.

[Online]. Available: https://www.businessinsider.in/science/news/heres-how-coronavirus-nose-and-throat-swab-tests-really-work-and-why-they-dont-always-give-satisfying-results/articleshow/

Kaggle input data links [Online] Available:

https://www.kaggle.com/datasets/preetviradiya/covid19-radiography-dataset

Kaggle input data links [Online] Available:

https://www.kaggle.com/datasets/tawsifurrahman/tuberculosis-tb-chest-xray-datase