# Detecting COVID-19 Symptoms using X-ray Image with Deep Learning Algorithm

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**Abstract—** Since the new coronavirus SARS-CoV-2 outbreak, ferocious exploration has been conducted to find suitable tools for opinion and relating to infected people in order to take applicable action. Chest imaging plays a significant part in this phase where CT and X Rays reviews have proven to be effective in detecting COVID-19 within the lungs. In this exploration, we propose deep literacy models using Transfer learning to describe COVID-19. BothX-ray and CT reviews were considered to estimate the proposed method.

**Keywords—** COVID-19, medical imaging,Transfer Learning, Deep Learning, Chest XRay Images, CT Scans

## 1.INTRODUCTION

In December 2019, the first case of the novel coronavirus pneumonia (COVID-19) was confirmed in Wuhan, China. In just two months, the number of confirmed cases rose to nearly 1000, with more than 5000 suspected cases. By September 2020, the novel coronavirus pneumonia epidemic had spread across the world, and the number of confirmed cases increased daily.

In the early stages of the epidemic, people knew very little about the novel coronavirus. According to the “Novel Coronavirus Diagnosis and Treatment Plan for Pneumonia infected by Bat disease (Trial Version 5),” released by the China National Health Commission on February 4, 2020, and the explanation by Dr. Nanshan Zhong of the COVID-19 epidemic, the novel coronavirus and SARS bat-like coronavirus (Bat-SL-CoVZC45) have over 85% homologies, belonging to the same family but not being the same kind [1]. On February 9, 2020, the team of academician Zhong Nanshan published a paper on the analysis of the clinical characteristics of the novel coronavirus pneumonia in China [2]. The study of 1099 positive patients and analysis of clinical samples revealed a number of clinical features of the novel coronavirus pneumonia infection, emphasising the main symptoms and radiological characteristics of the patient. In the diagnosis and treatment plan of the “Novel Coronavirus Infection Pneumonia Diagnosis and Treatment Plan (Trial Version 7),” issued by the National Health Commission [3], in addition to an incubation period of 1–14 days of isolation, observation based on epidemiological investigations, according to the clinical manifestations of pneumonia symptoms, characteristics of disease signs, laboratory nasopharyngeal swabs, nucleic acid test results of negative/positive, and effective oxygen therapy combined with antiviral and antimicrobial therapy, the most important diagnostic criterion is chest imaging.

For the initial research on COVID-19, Shan et al. proposed an automatic segmentation and quantification system based on deep learning, using image segmentation theory to study the chest computed tomography (CT) infection area and the overall structure of the lungs, and man-machine loop optimization to annotate each case [4]. Wang et al. from the Cancer Hospital of Tianjin Medical University used deep learning to extract COVID-19 image features, established a learning model to analyse positive cases and provided a theoretical basis for the timely and accurate diagnosis of

COVID-19 [5]. Experts from the Affiliated Hospital of Huazhong University of Science and Technology used three-dimensional CT to detect the novel coronavirus pneumonia and a three-dimensional neural network based on weakly supervised deep learning to classify positive and negative cases to quickly identify COVID-19 cases [6]. Researchers such as Asmaa and Mohammed from Arthurs University and Birmingham City University, aiming at the high availability of COVID-19 annotated image datasets, used convolutional neural networks (CNNs) to identify and classify novel coronavirus pneumonia images and a class decomposition mechanism to study its class boundary to deal with irregularities in the dataset, with good results [7]. Li used deep CNNs to study positive cases of chest CT image data of patients with novel coronavirus pneumonia [8]. Rehman et al. used pretrained knowledge and transfer learning to distinguish COVID-19 disease from viral pneumonia, bacterial pneumonia, and healthy people, so as to develop an effective diagnostic method [9].With the development of the epidemic, machine learning technology and deep learning technology have been applied in the detection of COVID-19 patients. Wang et al. applied an Inception network to CT to detect COVID-19 [5]. Asif et al. used a transfer learning inception V3 model to detect COVID-19 chest X-ray images, proving that the transfer learning method is robust and easy to expand for COVID-19 detection [10]. Song et al. used an improved version of the ResNet50 pretrained network to accurately classify healthy people, COVID-19, and bacterial pneumonia [11]. Loey et al. used the GooLeNet pretrained model to classify COVID-19, bacterial pneumonia, viral pneumonia, and normal people, with an 80.6% accuracy rate [12].

## 2.RELATED WORK

Since the novel coronavirus SARS-CoV-2 outbreak, intensive research has been conducted to find suitable tools for diagnosis and identifying infected people in order to take appropriate action. Chest imaging plays a significant role in this phase where CT and X Rays scans have proven to be effective in detecting COVID-19 within the lungs. In this research, we propose deep learning models using Transfer learning to detect COVID-19. Both X-ray and CT scans were considered to evaluate the proposed methods. The emergence of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; previously provisionally named 2019 novel coronavirus or 2019-nCoV) disease (COVID-19) in China at the end of 2019 has caused a large global outbreak and is a major public health issue. As of 11 February 2020, data from the World Health Organization (WHO) have shown that more than 43 000 confirmed cases have been identified in 28 countries/regions, with >99% of cases being detected in China. On 30 January 2020, the WHO declared COVID-19 as the sixth public health emergency of international concern. SARS-CoV-2 is closely related to two bat-derived severe acute respiratory syndrome-like coronaviruses, bat-SL-CoVZC45 and bat-SL-CoVZXC21. It is spread by human-to-human transmission via droplets or direct contact, and infection has been estimated to have a mean incubation period of 6.4 days and a basic reproduction number of 2.24-3.58. Among patients with pneumonia caused by SARS-CoV-2 (novel coronavirus pneumonia or Wuhan pneumonia), fever was the most common symptom, followed by cough. Bilateral lung involvement with ground-glass opacity was the most common finding from computed tomography images of the chest. The one case of SARS-CoV-2 pneumonia in the USA is responding well to remde sivir, which is now undergoing a clinical trial in China. Currently, controlling infection to prevent the spread of SARS-CoV-2 is the primary intervention being used. However, public health authorities should keep monitoring the situation closely, as the more we can learn about this novel virus and its associated outbreak, the better we can respond. In December, 2019, Wuhan, Hubei province, China, became the centre of an outbreak of pneumonia of unknown cause, which raised intense attention not only within China but internationally. Chinese health authorities did an immediate investigation to characterise and control the disease, including isolation of people suspected to have the disease, close monitoring of contacts, epidemiological and clinical data collection from patients, and development of diagnostic and treatment procedures. By Jan 7, 2020, Chinese scientists had isolated a novel coronavirus (CoV) from patients in Wuhan. The genetic sequence of the 2019 novel coronavirus (2019-nCoV) enabled the rapid development of point-of-care real-time RT-PCR diagnostic tests specific for 2019-nCoV (based on full genome sequence data on the Global Initiative on Sharing All Influenza Data [GISAID] platform). Cases of 2019-nCoV are no longer limited to Wuhan. Nine exported cases of 2019-nCoV infection have been reported in Thailand, Japan, Korea, the USA, Vietnam, and Singapore to date, and further dissemination through air travel is likely. As of Jan 23, 2020, confirmed cases were consecutively reported in 32 provinces, municipalities, and special administrative regions in China, including Hong Kong, Macau, and Taiwan. These cases detected outside Wuhan, together with the detection of infection in at least one household cluster—reported by Jasper Fuk-Woo Chan and colleagues in *The Lancet*—and the recently documented infections in health-care workers caring for patients with 2019-nCoV indicate human-to-human transmission and thus the risk of much wider spread of the disease. As of Jan 23, 2020, a total of 835 cases with laboratory-confirmed 2019-nCoV infection have been detected in China, of whom 25 have died and 93% remain in hospital

The existing study aims to detect whether patients examined are healthy, Coronavirus positive, or just have pneumonia based on chest X-ray data using Convolutional Neural Network method as feature extraction and Support Vector Machine as a classification method or called Convolutional Support Vector Machine. Experiments carried out were comparing the kernel used, feature selection methods, architecture in feature extraction, and separated classes. Our instrument reached an accuracy of 77.33% in the separation of 3 classes (normal, pneumonia, COVID19) and 100% in the separation of 2 classes, that is (normal, COVID19) and (pneumonia, COVID19), respectively. Based on these results, it can be concluded that the feature selection method can improve gained accuracy ±78%.

## I.METHODOLOGY

In this research, we propose a VGG-16 or 19 deep learning convolution models using Transfer learning to detect COVID-19.This deep learning model will be responsible for fast estimation of COVID-19 results by using trained X-ray images.In this project, we propose and train a VGG-16 or 19 deep learning convolution models using Transfer learning to detect COVID-19. This deep learning model will be responsible for fast estimation of COVID-19 results by using trained X-ray images and with high accuracy rate.

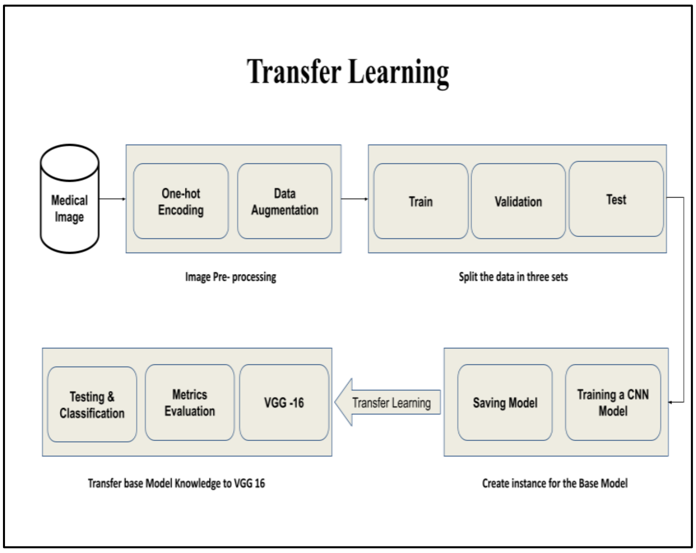


**Fig 1: Architecture using in this approach**

### A.Materials and Methods

The detection of COVID-19 in this article requires several stages, The original X-ray image is preprocessed, including size adjustment, rotation, position translation, cross-cutting transformation, scaling, and flip processing. The dataset is then divided into training and validation (test) sets. The preprocessed data are used to extract the modal feature information of the X-ray images through pretraining models by transfer learning, and this is input to the fully connected (FC) layer and trained after fusion. The first two layers of the FC layer contain 512 hidden units, followed by the ReLU activation function, and the last layer contains a hidden unit, followed by the sigmoid activation function, which is used to detect COVID-19. The performance of the system is evaluated by indices such as accuracy, recall rate, precision, and F1-score.

### B.Datasets

The database consists of 3616 COVID-19 positive cases along with 10,192 Normal, 6012 Lung Opacity (Non-COVID lung infection), and 1345 Viral Pneumonia images.The dimensions of the image are 128 pixels width and 128 pixels height, one single colour channel. The maximum pixel value is 1.4452 and the minimum is -3.0251. The mean value of the pixels is 0.0000 and the standard deviation is 1.0000.

### C.Preprocessing

The resulting dataset contains XRay images with different shapes and resolutions. In order to normalise the input dataset and ensure consistency across all dataset, we reshaped all images with a fixed size of 224×224 pixels.

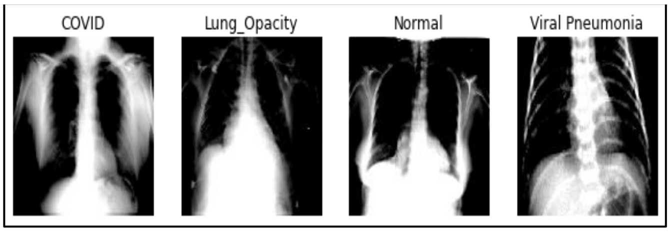


**Fig 2: Sample of X-Ray dataset**

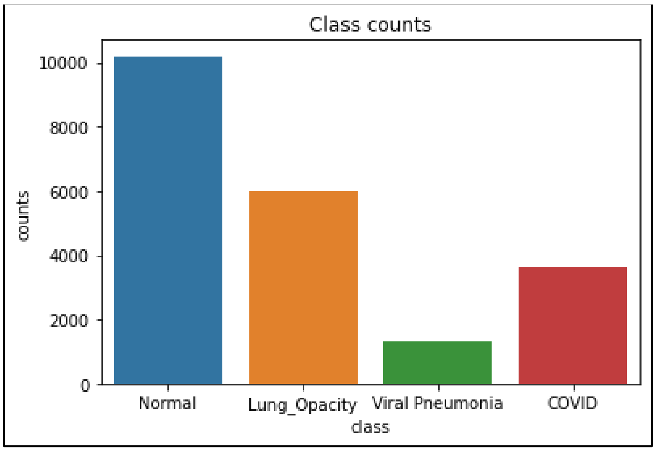


**Fig 3: Each Classes Count**

### D.Deep Learning

In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks.In deep learning, a convolutional neural network (CNN/ConvNet) is a class of deep neural networks, most commonly applied to analyse visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics convolution is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other.

### E.Transfer Learning

Transfer learning improves learning by transferring knowledge from related tasks that have been learned, i.e., transferring learned and trained parameters to a new model to help with its training [21]. The architecture of deep learning models is complex and data dependent, requiring much data to train them. Much COVID-19 data are published online, but the number of samples is small, making it difficult to train a deep learning model from start to finish. Transfer learning can facilitate the training of such a small sample dataset to achieve the research purpose.

Apostolopoulos et al. adopted transfer learning to detect the performance of different models in a small sample of pneumonia image datasets [18]. Rafi [22] used chest X-ray images to identify patients with COVID-19, using transfer learning methods to train DenseNet121 and ResNet152 series models. Taresh et al. discussed the effectiveness of artificial intelligence in the rapid and reliable detection of COVID-19 based on chest X-ray images and applied transfer learning technology to detect COVID-19 from chest radiographs [23]. Majeed et al. compared 12 transfer learning CNNs in the detection of COVID-19 from chest X-rays [24].

The COVID-19 samples collected for our experiment were limited. To obtain better experimental results, different CNN models trained on ImageNet, a database of approximately 14 million images, were used to train the COVID-19 dataset.

### F.VGG Architecture

The VGG [28] family is used in face recognition and image classification, where VGG19 has better performance. VGG19 has 19 hidden layers, consisting of 16 convolutional layers and three fully connected layers. The input is set to $224 \times 224$ RGB images. The RGB average of all images is calculated on the training set image, and the image is passed as input and enters the VGG19 convolutional network.

DenseNet [29] builds a connection relationship between layers, makes full use of features, and further alleviates the problem of gradient disappearance. The use of a bottleneck layer, translation layer, and smaller growth rate makes the network narrower, reduces the parameters, effectively suppresses overfitting, and reduces calculation.

## II.System Component

All experiments are carried out on the google colab server, using the Tesla Nvidia K80 / T4 -16 GB GPU graphics card and python language tensorFlow/keras framework.

### A.Data Preprocessing and Training of Parameter Settings

We discuss and analyse the experimental results. Before training the model, we normalised the training and validation (test) datasets to decimal values between (0, 1) or (1, 1), so as to make training more convenient and faster. Since the experiment used small samples, the training and validation datasets were scaled. The input size of the VGG19 network models was $224 \times 224$, so the input image size was set to that size.

In the preprocessing stage, all parameters were set the same to enhance the sample data. In the training phase, we first set empirical values for some main parameters, e.g., a learning rate of 0.01 and batch size of 128, with 10 epochs and 128 nodes in the first two layers of the FC layer. In the training process, loss converges according to the learning rate. Loss that does not converge is probably due to too high learning rate, and slow convergence usually means the learning rate is set too low. In this experiment, the learning ability of the model was best with a learning rate of 0.001. When the accuracy is very low, the batch size can be reduced while keeping the number of epochs unchanged, which will improve the accuracy because the larger the batch size, the faster the processing. In the case of constant epochs, the batch size needs to be reduced to achieve the same accuracy. After many adjustments and experiments, the batch size and number of epochs were set to 16 and 500, respectively (except for model 2, with 1000 epochs).

## III.EXPERIMENTS AND RESULTS

Underfitting or overfitting may occur during training, and the number of nodes in the FC layer and the dropout size can be adjusted appropriately. The number of nodes in the FC layer and the dropout was set to 512 and 0.5, respectively, but the loss curves of training and testing showed severe jitter, so momentum was added to reduce jitter, and this was set to 0.9 for better model learning.

| Model | Train Accuracy Score | Test Accuracy Score |
|---|---|---|
| Custom CNN | 0.93 | 0.87 |
| TL - VGG16 | 0.95 | 0.94 |

**Table 1: Performance Analysis**

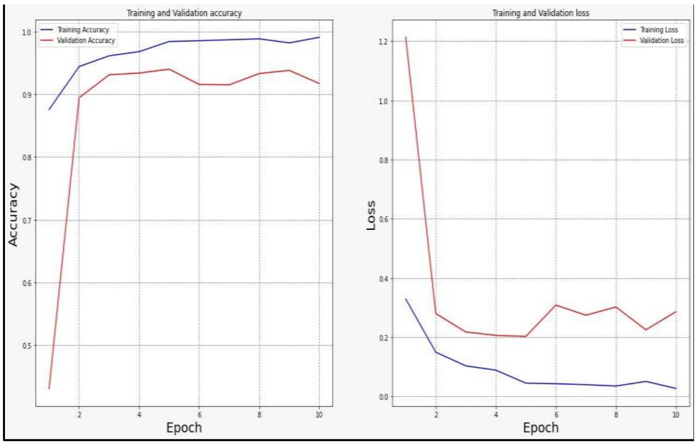


**Fig 4: Training and Validation Curve**

## IV.CONCLUSION

In this paper, we propose a transfer learning approach for the purpose of detecting COVD-19 cases using Xray and CT scan images. We used our custom CNN network to train our dataset based on knowledge of the custom CNN model. We transferred knowledge to the VGG16 pre-trained model. The developed approach outperformed the baseline model, consisting of the VGG16 model.

## REFERENCE

1. Novel Coronavirus Diagnosis and Treatment Plan for Pneumonia Infected by Bat Disease (trial version 5), 2000.
2. W.-j. Guan, Yu Hu, W.-h. Liang et al., *Clinical Characteristics of 2019 Novel Coronavirus Infection in China*, MedRxiv, Cold Spring, NY, USA, 2020.
3. J.-Y. Zhao, J.-Y. Yan, and J.-M. Qu, "Interpretations of "diagnosis and treatment protocol for novel coronavirus pneumonia (trial version 7)"," *Chinese Medical Journal*, vol. 133, no. 11, pp. 1347–1349, 2020. View at: Publisher Site | Google Scholar
4. F. Shan, Y. Gao, J. Wang et al., "Lung infection quantification of covid-19 in ct images with deep learning," 2020, https://arxiv.org/abs/2003.04655. View at: Google Scholar
5. S. Wang, B. Kang, J. Ma et al., "A deep learning algorithm using ct images to screen for coronavirus disease (COVID-19)," *European Radiology*, vol. 31, 2020. View at: Publisher Site | Google Scholar
6. C. Zheng, *Deep Learning-Based Detection for COVID-19 from Chest CT Using Weak Label*, medRxiv, Cold Spring, NY, USA, 2020.
7. A. Abbas, M. M. Abdelsamea, and M. M. Gaber, "Classification of COVID-19 in chest x-ray images using detrac deep convolutional neural network," *Applied Intelligence*, vol. 51, 2020. View at: Google Scholar
8. L. Li, "Using artificial intelligence to detect COVID-19 and community-acquired pneumonia based on pulmonary CT: evaluation of the diagnostic accuracy," vol. 296, no. 2, 2020. View at: Publisher Site | Google Scholar
9. A. Rehman, S. Naz, A. Khan, A. Zaib, and I. Razzak, *Improving Coronavirus (Covid-19) Diagnosis Using Deep Transfer Learning*, MedRxiv, Cold Spring, NY, USA, 2020.

10. S. Asif, Y. Wenhui, H. Jin, Y. Tao, and S. J. M. Jinhai, *Classification of Covid-19 from Chest X-ray Images Using Deep Convolutional Neural Networks*, MedRxiv, Cold Spring, NY, USA, 2020.
11. Y. Song, *Deep Learning Enables Accurate Diagnosis of Novel Coronavirus (COVID-19) with CT Images*, MedRxiv, Cold Spring, NY, USA, 2020.
12. M. Loey, F. Smarandache, and N. E. Khalifa, "Within the lack of chest COVID-19 X-ray dataset: a novel detection model based on gan and deep transfer learning," *Symmetry*, vol. 12, no. 4, p. 651, 2020. View at: Publisher Site | Google Scholar
13. M. Rahimzadeh and A. Attar, "A modified deep convolutional neural network for detecting COVID-19 and pneumonia from chest X-ray images based on the concatenation of Xception and ResNet50V2," *Informatics in Medicine Unlocked*, vol. 19, 2020. View at: Publisher Site | Google Scholar
14. A. E. Hassanien, L. N. Mahdy, K. A. Ezzat, H. H. Elmousalami, and H. A. J. M. Ella, *Automatic X-ray Covid-19 Lung Image Classification System Based on Multi-Level Thresholding and Support Vector Machine*, MedRxiv, Cold Spring, NY, USA, 2020.
15. A. M. Alqudah, S. Qazan, H. Alquran, I. A. Qasmieh, and A. Alqudah, "COVID-2019 detection using x-ray images and artificial intelligence hybrid systems," *Biomedical Signal and Image Analysis and Project*, 2020. View at: Publisher Site | Google Scholar
16. A. A. Osi, *A Classification Approach for Predicting COVID-19 Patient Survival Outcome with Machine Learning Techniques*, MedRxiv, Cold Spring, NY, USA, 2020.
17. S. Kumar, S. Mishra, and S. K. J. M. Singh, *Deep Transfer Learning-Based COVID-19 Prediction Using Chest X-Rays*, MedRxiv, Cold Spring, NY, USA, 2020.
18. I. D. Apostolopoulos, T. A. J. P. Mpesiana, and E. S. i. Medicine, "Covid-19: automatic detection from x-ray images utilising transfer learning with convolutional neural networks," vol. 1, 2020. View at: Publisher Site | Google Scholar
19. M. J. Horry, M. Paul, A. Ulhaq, B. Pradhan, M. Saha, and N. Shukla, *X-Ray Image Based COVID-19 Detection Using Pre-trained Deep Learning Models*, MedRxiv, Cold Spring, NY, USA, 2020.
20. P. K. Sethy and S. K. J. P. Behera, "Detection of coronavirus disease (covid-19) based on deep features," *International Journal of Mathematical, Engineering and Management Sciences*, vol. 5, 2020. View at: Google Scholar