Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

Performance Assessment of DL Model in Iraq for Covid-19 Patient Severity Prediction from X-Ray Scan Images

Aseel Nadhum Kadhum*

[*]Imam Al-Kadhim College, Iraq.

Corresponding Email: [1]easeel18@yahoo.com*

Received: 25 May 2023 **Accepted:** 12 August 2023 **Published:** 01 October 2023

Abstract: ***The livelihoods of many people are greatly affected by the covid-19 virus, and the high death rate has led to a global pandemic. With early detection, the possibility of spreading coronavirus (covid-19) can be reduced. The way people live their lives and the global economic and social systems have undergone a major transformation. It is difficult to treat almost all cases of coronavirus due to limited medical infrastructure, causing the death toll to rise rapidly. Therefore, thousands of lives could be saved if their occurrence and severity could be predicted in advance, allowing the rapid adoption of appropriate treatments. Deep learning (DL) is crucial for determining the severity of the lungs in patients with Covid-19. The severity of lung disease among Covid-19 patients is determined using a variety of techniques, including X-rays, CT scans and MRI scans. The prediction result depends highly on how well each stage of lung disease detection performs. The low prediction accuracy leads to a major reason: the large size of the storage model. To address this problem, in order to increase predicting accuracy, it is suggested that the new deep transfer learning model be enhanced by the incorporation of a novel attention mechanism. VGG16 is used as the foundation model for a brand-new deep transfer learning model. We suggest adding a convolutional block attention module (GhostNet) to the conventional suggested network model and upgrading a new model for this purpose in order to improve the accuracy of forecasting the severity of lung illness among Covid-19 patients.***

Keywords: Deep Learning (DL), Covid-19 Patient Severity, Enhanced CNN, X-Ray.

1. INTRODUCTION

China reported its first case of Covid-19 to the Wuhan Municipal Health Commission in December 2019. This epidemic caused by Covid-19 is considered one of the deadliest diseases in the past few years. On August 12, 2021, the World Health Organization (WHO) announced that cases reached 203,944,144 patients while deaths reached 4,312,902 patients globally [18].

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

SARS (Severe Acute Respiratory Syndrome) is a disease related to Covid-19 that has caused a significant threat to public health and an epidemiological investigation has been suggested. This disease has symptoms such as coughing, dizziness, and fever, in addition to the risks that Covid-19 patients face in various circumstances [3].

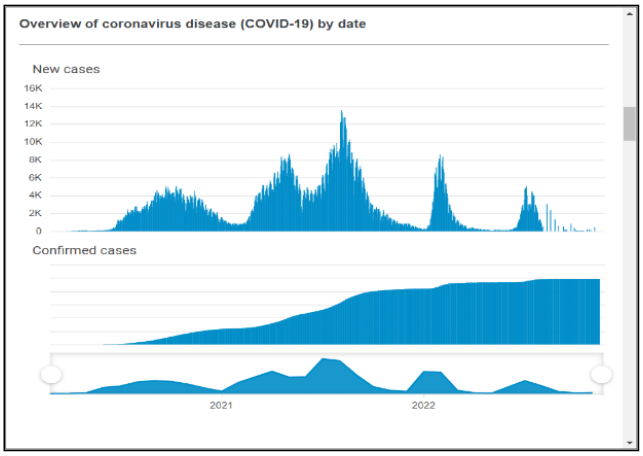


Figure 1: Deaths and confirmed cases related to Covid-19 in Iraq from February 24- 2020 to October 5- 2022

As in the above graph, the trend of increasing death can be seen. The data was collected from Iraq from February 24, 2020 to October 5, 2022. As we can see, there is a huge increase in confirmed cases of Covid-19 as well as in deaths. [4] Taking into account the mortality figures shown in the previous chart and all other outcomes of this disease, it was decided to undertake this work. The main driver is the ability to help mitigate the health consequences of the virus, helping doctors diagnose the disease and make decisions about treatment.

The standard for diagnosing Covid-19 patients is RT-PCR, although this process often takes a long time, the initial viral concentration is not high, and it is easy to get false negative results. Computed tomography (CT) and X-rays are therefore essential in making adjunctive diagnosis and are useful tools for determining the prognosis and course of the disease. As a result, deep learning is frequently used in diagnostics. [6]

X-ray and CT scans are often used along with CAD (Computer Aided Diagnosis) in order to predict Covid-19, as manual work on X-ray and CT images is a very difficult task [7]. A chest CT scan is very useful because it detects cystic fibrosis, lung problems, and chronic lung diseases [6]. It has been proven that anyone can get Covid19, regardless of gender, age or race. The disease can progress from asymptomatic respiratory distress syndrome to organ dysfunction and eventually death. When someone recovers from Covid-19, which usually takes two weeks for mild cases or three to six weeks for severe cases, symptoms are more widespread. The immune system, cancer, pregnancy, diabetes, cardiovascular disease, and diabetes increase the risk of developing a serious condition [8].

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

The decision to carry out this work was taken after taking into account the mortality rates shown in the previous graph. The main motivation is the ability to minimize the negative health effects of the virus and to support professionals in their work.

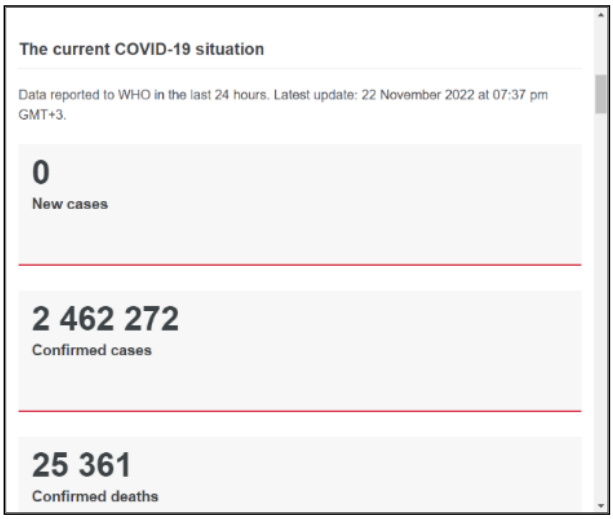


Figure 2 Recent WHO updates for Covid-19 cases (confirmed, total deaths, nationwide)

The above details were obtained from, which shows total confirmed cases, total deaths, total immunized cases [4]. The workforce constraints in diagnosing and treating the frontlines of an overburdened pandemic can be addressed in part by developing clinically applicable medical AI technology. X-ray examination, early detection of condition change, and timely management.

Problem Background

The impact of the outbreak was evident in Iraq, where the first death related to Covid19 was confirmed on February 27, 2020. About 25,356 people have been killed in our country, according to the official Iraqi News Agency [4]. A statistic for the world meter website, which specializes in tracking new infections around the world, indicated that during the month (January), Iraq ranked 27th in the world and the first in the Arab world in terms of the total number of coronavirus infections, according to the latest report [4][3].

Since hospitals in Iraq are unable to provide the necessary medical care, the context for this work is the inability of health systems to predict future risks and deaths due to the coronavirus. In order to identify Covid-19 patients in medical images, the researchers looked for a variety of DL structures. In a recent study, the researchers developed a CNN model based on the VGG16 virus detection network. Experimental results show that the model has an accuracy of 90%. The model focuses on the affected areas in the CT lung image from open source [5].

Mertyuz et al. [6] in Oct. 2020, the proposed Covid-19 prognosis from CXRI utilizing three DCNN variations (VGG-16, ResNet, GoogleNet). The dataset obtained from a public platform [7] includes Covid-19 positive (219), normal (1341), and viral pneumonia (1345) photos. The

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

suggested technique achieves accuracy for the VGG-16 network at 95.87%, ResNet at 96.90%, and GoogleNet at 95.18%.
They [8] built a transfer learning pipeline to categorize covid-19 chest X-ray pictures from two datasets of chest X-rays that are available to the public. They obtained an overall detection accuracy of 90%, 94.3%, and 96.8% for the VGG16, ResNet50, and EfficientNetB0 backbones, respectively, using multiple pre-trained convolutional backbones as the feature extractor.
They suggest and assess a method based on transfer learning using the VGG-16 model, experimental analysis of 6523 chest X-rays from various institutions, and a covid-19 detection accuracy of 0.97 [9].
To the knowledge of the researcher and according to previous studies, there was only a diagnosis of Corona disease, and the severity of lung disease for covid-19 patients was not determined in abundance for studies regarding the VGG16 model.

Problem Statement
The absence of technical resources has various effects on the health system. The advancement of technology today could make it possible to gauge, comprehend, and anticipate the seriousness of an illness. We can identify epidemics like Covid-19 and assist governments as well as the healthcare industry by investigating and developing a one of the CNN model based on deep learning. When all technical means are used, modeling and forecasting severity Covid-19 becomes a very difficult challenge, especially in societies with poor data infrastructures. The majority of forecasting models used in past studies have small sample sizes and weak validation generalizability. The returning variables are unknown and abstracted over several layers of the model and neurons, which reduces their interpretability and transparency when taking into account demographic variations between patient groups.

Research Scopes
The dataset information for infected patients will be from Babylon's three private hospitals. And it will have used application of open source tools such as programming language. (Python and R as well as cross-platform libraries), and create a database in an Excel file with a .csv extension.

Research Aim
The reasons for considering deep learning analysis as a way to verify the effectiveness of the prediction model in Covid-19 patients are based on the fact that the healthcare system in Iraq is in crisis. Overcrowding in hospitals can help, as the best prediction method is being sought at the computational level. By achieving timely prevention and treatment of infection, we can get closer to eliminating the epidemic at the Iraqi level. Due to the health crisis, the treatment capacity of his hospital is at or over 100%. Deep learning technologies enable automatic and accurate prediction of severe cases of Covid-19 patients and address the problem of misdiagnosis of pneumonia.

Technical Proposal Design
Due to its capacity to represent local operations, the network convolutional neural network is frequently employed in computer vision tasks. The fully connected layer, pooling layer, and

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

convolutional layer make up the network model. The backpropagation technique optimizes the parameters of each convolution unit in the convolutional layer, which consists of many convolution units. The convolutional layer's job is to take the input image and extract various information from it. A crucial component of the convolutional neural network is the Pooling layer. Data de-sampling is the purpose. Reduce the amount of data that needs to be processed at the subsequent layer, cut back on the number of parameters, and prevent network overfitting are the three goals of this technique. The completely connected layer can integrate local information with category classification in the convolutional layer or pooling layer because every neuron in the layer is fully connected to every neuron in the layer below [11].

The VGG16 convolutional neural network model, created by the Visual Geometry Group (VGG) at the University of Oxford, won the 2014 ILSVRC object identification algorithm. The primary objective of VGG16 is to illustrate how, in some circumstances, network performance can be enhanced by network deepening. The main difference between the original AlexNet and VGG16 is the replacement of several smaller 3 × 3 convolution cores with larger convolution cores (11 × 11, 7 × 7, 5 × 5) that can significantly improve network performance by reducing the number of parameters and increasing the depth of the network. Fig. 3 depicts the VGG16 network model, which consists of 13 convolutional layers, three fully connected layers, and five pooling layers.

VGG16 successfully improves network performance by flexibly expanding the depth of the network through the use of 3 × 3 convolution while preserving the straightforward structure of the classical network. But there are also some application concerns with the VGG16 model. First, the front-end deployment of the VGG16 model is complicated by the fully connected layer's numerous parameters, which use a lot of memory and processing resources. Second, the network model with its single structure performs poorly when compared to some complicated advanced networks. Gradient explosion and delayed convergence speed are likely to occur during training since the VGG16 model does not have a reliable technique to prevent gradients from vanishing [12].

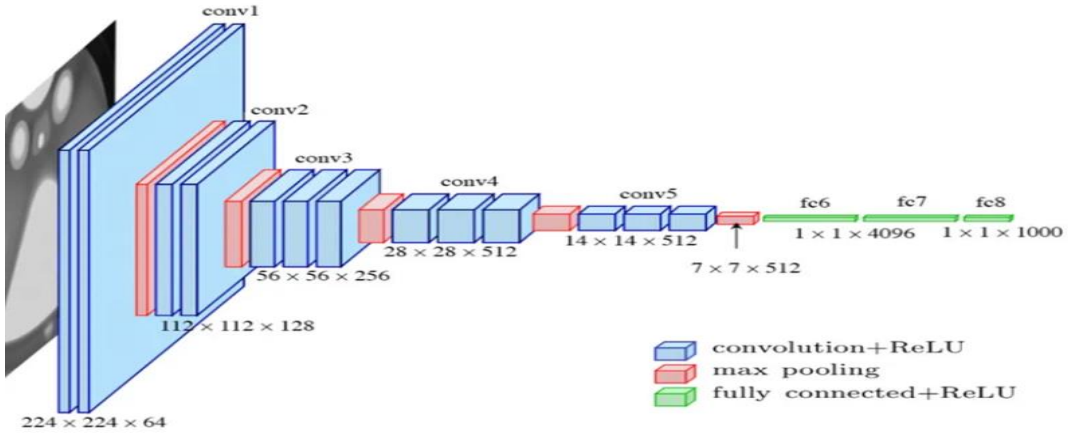


Figure 3. The Structure of VGG16 Architecture

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

The improved VGG16 model uses the following as its main optimization method:
At the beginning we work on the image pre-processing step to use lung x-ray imaging, which is considered as input data for our research paper. By changing the size of the images as well as dividing the image data into subsets for training and validation. In addition, we are working on the method of increasing the data by applying the standard reinforcement method to increase the volume of training data and diversity in trends.

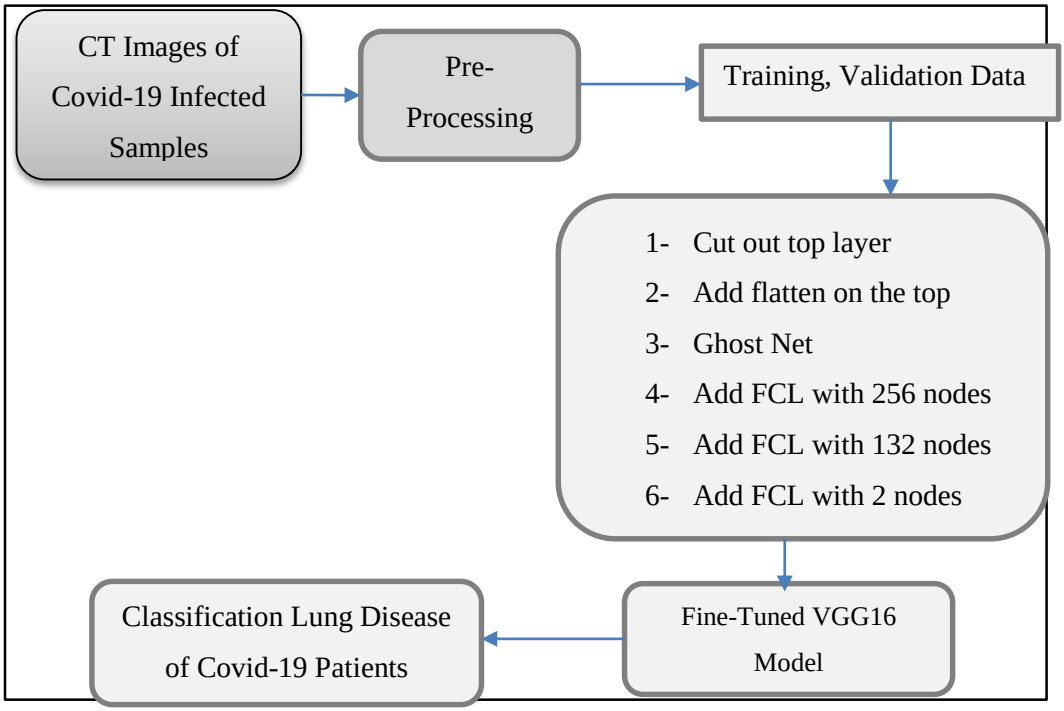


Figure 4. The Proposed Convolutional Neural Network (VGG16) Model's Architecture

Next, we modify the original structure of the VGG16 model shown in Figure 3. We will keep the original VGG16 model unchanged until the last layer, where we remove the fully connected layers FC6 and FC7 from VGG16. A new flat layer is added to the model. And we also merge Ghost into VGG16 after adding the new flat layer. The VGG16 has a large number of parameters and a high resource consumption since its completely linked layers FC6 and FC7 connect every neuron to every neuron in the layer before. It is important to completely remove these two related layers as a result. Ghost is a cutting-edge idea that creates additional feature maps using low-cost technologies. We successfully perform a variety of linear modifications to a set of intrinsic feature maps in order to generate numerous ghost feature maps that can fully reveal the information concealed behind the intrinsic features [13].

Overfitting is avoided, prediction accuracy is enhanced, and final models are perfect for local deployment on limited-capability devices without the requirement for Internet access by increasing the size of the data set while decreasing network capacity and model size as much as feasible. The convolutional layer duplicates the feature maps, producing an expensive outcome. "Ghost feature maps" are the product of the authors ' excessive repetition. The new

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

Ghost module that has been presented shrinks the size of the model and lowers computational costs without significantly sacrificing accuracy [19].
Next, we add two FCL lines. In these two convolutional layers, a modified linear unit (ReLU) is used as the activation function [10]. In the final step of this fine-tuning process, we add the classification layer, which uses Softmax as the activatio function to perform a new task of predicting the lung disease severity of covid-19 patients in two categories.

Data Set
In this work, a chest x-ray pneumonia database from different hospitals of Babylon province was used, which consisted of 5247 chest x-ray images. This dataset was divided into training and test set. Figure 5 eexhibits some sample chest X-rays from our experimental dataset.

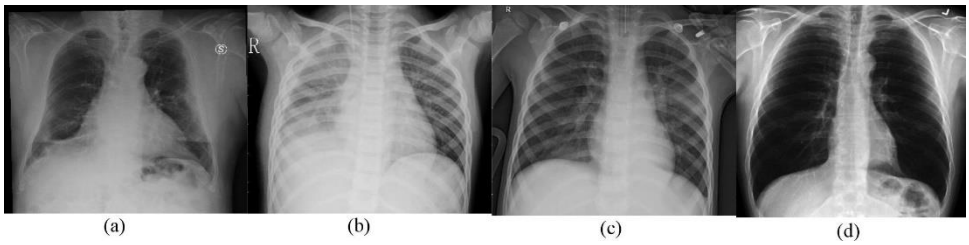


Figure. 5. Sample Dataset

Training Phase
Here the algorithm is trained to recognize patterns of information stored in datasets with 5247 patterns obtained through high resolution images provided by Babylon Hospitals. The training phase allows us to build deep learning models; At this point, we will train our algorithms to recognize patterns in information, in the current case that would be information provided by x-ray images The data will be divided into 80% training and 20% for the testing phase; Therefore, 3,000 images from the training dataset, which the algorithm will provide so that it can learn within the covid-19 category, will be used as information output based on the prediction, light or severe.
In the process of training the VGG16 geometry, all the set of images stored in the datasets will be exposed. The condition for preparing the syntax for neural training corresponds to the clustering of the model, which is achieved by the clustering method based on the cost function by measuring the binary cross error; It denotes a function of binary type. The optimization methods used to train our convolutional neural network to predict Covid-19 by X-rays are based on optimization criteria by gradient descent based on the learning coefficient of a deep learning model [14].

Implementation of The Trained Convolutional Network Through the Transfer Learning Process & Evaluation.
The technique used in the deep learning model development process is known as transfer learning. This method is used to use pre-trained models in various databases which focus on modifying the rest of the output layer of the convolutional network. The application of advanced transfer learning technology helps to focus on the most representative data of

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

datasets. This technique avoids losing weights by calculating the parameters conditioned by the data obtained from the training.

Within the optimization dynamics, it considers previously defined parameters, which proceeded to insert 4 models to measure different learning rate values. The performance of the models in the proposed study is assessed using the next metrics . Where TP, TN, FP, and FN stand, respectively, for true positive, true negative, false positive, and false negative measures [15].

Within the Tensor Flow platform there are several graphical visualization tools to measure data stress. This allows the application of training graphs, generating quantitative measures of the quality of the deep learning models to be analyzed.

$$\text{Accuracy} = \frac{\text{TP} + \text{TN}}{\text{TP} + \text{TN} + \text{FP} + \text{FN}}$$

$$\text{Specificity} = \frac{\text{TN}}{\text{TN} + \text{FP}}$$

$$\text{Sensitivity} = \frac{\text{TP}}{\text{TP} + \text{FN}}$$

$$\text{Precision} = \frac{\text{TP}}{\text{TP} + \text{FP}}$$

The graphics used in the results are obtained by an order entered into the coding cells; Before implementing neural network training, it must be borne in mind that it consists of generating content periodically throughout the training phase and terminating the process within the same machine. Representative graphs of the different scenarios implemented in the training phase are analysed. It is designed to analyse the properties of the micrograph and the graph of the loss function [16].

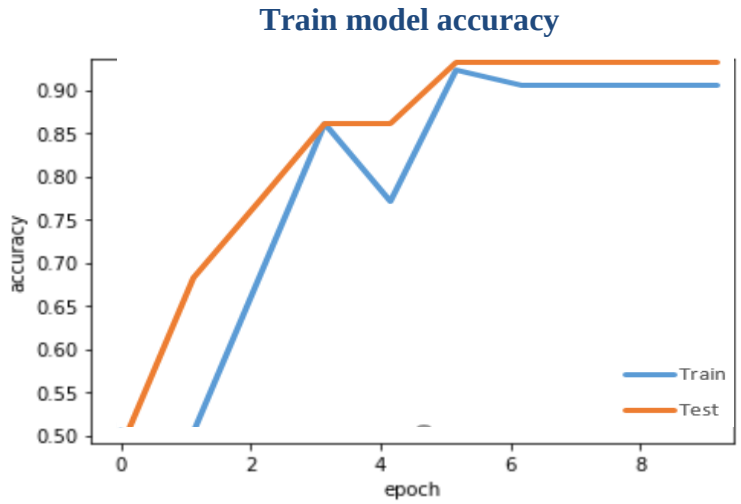
For the initial discovery of covid-19, there weren't many labeled photo datasets. As a result, overfitting is a possibility. Both the size of the data set being collected and the number of image data points being used rose. Improved results may result from increased data collecting. In our present method, Ghost is added to the model that manages these taxonomy duties. X-ray equipment would be simple to incorporate in smaller facilities as it is widely used in conventional hospital setups and is easily accessible. Additionally, X-ray equipment has cheaper running costs than RT-PCR because it requires less chemical upkeep. Anyone carrying metals or pregnant women may experience harm from X-ray scanning. With 98.8% accuracy, 92.75 specificity, 93.37 sensitivity, and 93.07 precision, the optimization produced its predictions.

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

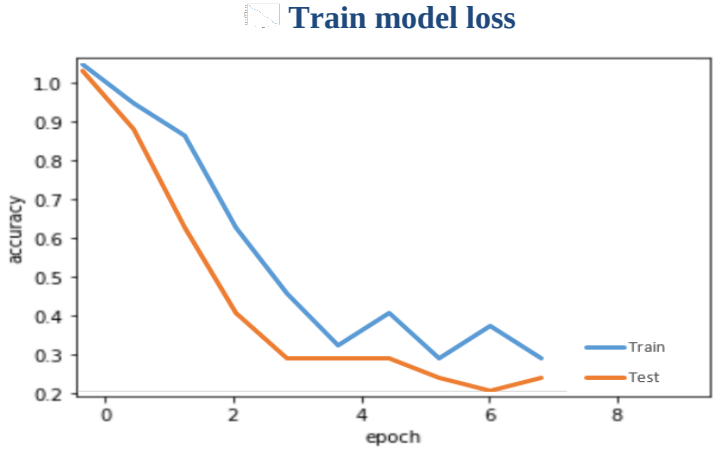
Table 1 Comparison of the improved VGG16 and with the original VGG16 in the test data set. Shows 98.8% accuracy.

Model VGG16	Source	%Accuracy
Original	Abdar, A. K,els [5]	90%
	Mertyüz, İ,els [6]	95.87%
	Zebin, T.,els [8]	90%
	Brunese, L.,els [9]	97%
Improved VGG16	98.8%	

Within optimizing algorithms, this function will evaluate the solution, which is known as an objective function. This type of function is based on maximizing or minimizing values to get a high or low percentage.



Graph 1: DL model epoch accuracy graph



Graph 2: Error decrease graph by season

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

Source: Made by the researcher

Within the assessment obtained at the training stage; Graph 1 denotes the curve associated with the training dataset, while Graph 2 denotes the validation sample of said model [17]. The exact graph runs on a [0.9] period, while the loss level is [0, 20].

2. CONCLUSION AND FUTURE WORKS

Where labeled data is limited, deep learning techniques can be improved by adopting methods such as semi-supervised and unsupervised learning using unlabeled data or transfer learning using learned models. The disadvantage of transfer learning methods is that they produce very large and bulky models, which makes them difficult to use in teams with limited resources. In rural or underdeveloped places, they may also need an internet connection to deploy the cloud, which is not always available. This study uses CNN imaging and x-rays to provide new models for determining the severity of covid-19 patients in Iraq. The latest image classification techniques, CNNs, excel in nonlinear conditions and in higher dimensional environments. The accuracy of the proposed CNN models has increased since previous studies, and they now provide accurate diagnoses in more categories of output. The recommended model VGG16 used the following two methods to prevent overfitting: increasing the size of the data set while balancing different classification scenarios, and using regularization strategies such as dropouts and hyperparameter optimization are all examples of regularization strategies.
The improved model outperformed the original model with an accuracy of 98.08% for the binary classification (mild or severe).
The proposed models may be updated in the future to include more classes of output and be tested on more images. Models created with Tensor Flow and Python.

3. REFERENCES

1. Wu, F., Zhao, S., Yu, B., Chen, Y. M., Wang, W., Song, Z. G., ... & Zhang, Y. Z. (2020). A new coronavirus associated with human respiratory disease in China. .Nature, 579(7798), 265-269
2. Wu, Z., & McGoogan, J. M. (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. jama, 323(13), 1239-1242.
3. Rasul, G., Nepal, A. K., Hussain, A., Maharjan, A., Joshi, S., Lama, A., ... & Sharma, E. (2021). Socio-economic implications of COVID-19 pandemic in South Asia: emerging risks and growing challenges. .Frontiers in sociology, 6, 629693
4. ISSAM S. ISMAIL, Wassit Health Directorate, Iraq (2020), 'Projecting the Short-Term Trend of COVID-19 in Iraq', https://doi.org/10.1145/3431769
5. Abdar, A. K., Sadjadi, S. M., Soltanian-Zadeh, H., Bashirgonbadi, A., & Naghibi, M. (2020, November). Automatic detection of coronavirus (COVID-19) from chest CT images using VGG16-based deep-learning. In 2020 27th National and 5th International Iranian Conference on Biomedical Engineering (ICBME) (pp. 212-216). IEEE.

Journal of Image Processing and Intelligent Remote Sensing
ISSN 2815-0953
Vol: 03, No. 06, Oct-Nov 2023
http://journal.hmjournals.com/index.php/JIPIRS
DOI: https://doi.org/10.55529/jipirs.36.1.11

6. Mertyüz, İ., Mertyüz, T., Taşar, B., & Yakut, O. (2020, October). Covid-19 disease diagnosis from radiology data with deep learning algorithms. In 2020 4th International Symposium on Multidisciplinary Studies and Innovative Technologies (ISMSIT) (pp. 1-4). IEEE.
7. COVID, K. (19). Radiography Database. Radiological Society of North America (2019). Available online at: https://www. kaggle. com/tawsifurrahman/covid19-radiography-database (accessed October 1, 2021).
8. Zebin, T., & Rezvy, S. (2021). COVID-19 detection and disease progression visualization: Deep learning on chest X-rays for classification and coarse localization. Applied Intelligence, 51, 1010-1021.
9. Brunese, L., Mercaldo, F., Reginelli, A., & Santone, A. (2020). Explainable deep learning for pulmonary disease and coronavirus COVID-19 detection from X-rays. Computer Methods and Programs in Biomedicine, 196, 105608.
10. Abbasi, W. A., Abbas, S. A., Andleeb, S., Ul Islam, G., Ajaz, S. A., Arshad, K., ... & Abbas, A. (2021). COVIDC: An expert system to diagnose COVID-19 and predict its severity using chest CT scans: Application in radiology. Informatics in Medicine Unlocked, 23, 100540.
11. Yan Q, Wang B, Gong D, Luo C, Zhao W, Shen J, et al. COVID-19 chest CT image segmentation: a deep convolutional neural network solution; 2020.
12. Prada, J., Gala, Y., & Sierra, A. L. (2021). COVID-19 mortality risk prediction using X-ray images.
13. Althubiti, S. A., Alenezi, F., Shitharth, S., K, S., & Reddy, C. V. S. (2022). Circuit manufacturing defect detection using VGG16 convolutional neural networks. Wireless Communications and Mobile Computing, 2022, 1-10.
14. Fan DP, Zhou T, Ji GP, Zhou Y, Chen G, Fu H, et al. Inf-Net: automatic COVID-19 lung infection segmentation from CT images. 2020
15. Hao, Y., Xu, T., Hu, H., Wang, P., & Bai, Y. (2020). Prediction and analysis of corona virus disease 2019. .PloS one, 15(10), e0239960
16. Lu, S., Lu, Z., & Zhang, Y. D. (2019). Pathological brain detection based on AlexNet and transfer learning. Journal of computational science, 30, 41-47.
17. Wu, C., Chen, X., Cai, Y., Zhou, X., Xu, S., Huang, H., ... & Song, Y. (2020). Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA internal medicine, 180(7), 934-943.
18. ISSAM S. ISMAIL, Wassit Health Directorate, Iraq (2020), 'Projecting the Short-Term Trend of COVID-19 in Iraq'.
19. Wang, Z., & Li, T. (2022). A lightweight CNN model based on GhostNet. Computational intelligence and neuroscience, 2022.