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# Cloud Computing on Pneumonia (during COVID-19) Prediction Using CNN Algorithm

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**Abstract**: COVID-19, a deadly disease originated in 2019 is still affecting millions across the globe and has become a global pandemic. The virus is continuously mutating and Omicron being the latest mutated variant (2022). Most nations had to take measures to react to the sudden and rapid outbreak of COVID-19 within a relatively short period of time. Because radiographs such as X-rays and computed tomography (CT) scans are cost-effective and widely available at public health facilities, hospital emergency rooms (ERs), and even at rural clinics, they could be used for rapid detection of possible COVID-19-induced lung infections. Therefore, toward automating the COVID-19 detection, in this paper, we propose a viable and efficient deep learning-based chest radiograph classification (DL-CRC) framework to distinguish the COVID-19 cases with high accuracy from other abnormal (e.g., pneumonia) and normal cases. A unique dataset is prepared from four publicly available sources containing the posteroanterior (PA) chest view of X-ray data for COVID-19, pneumonia, and normal cases. Our proposed DL-CRC framework leverages a data augmentation of radiograph images (DARI) algorithm for the COVID-19 data by adaptively employing the generative adversarial network (GAN) and generic data augmentation methods to generate synthetic COVID-19 infected chest X-ray images to train a robust model. The training data consisting of actual and synthetic chest X-ray images are fed into our customized convolutional neural network (CNN) model in DL-CRC, which achieves COVID-19 detection accuracy of 98.94% compared to 54.55% for the scenario without data augmentation (i.e., when only a few actual COVID-19 chest X-ray image samples are available in the original dataset). Furthermore, we justify our customized CNN model by extensively comparing it with widely adopted CNN architectures in the literature, namely ResNet, Inception-ResNet v2, and DenseNet that represent depth-based, multi-path-based, and hybrid CNN paradigms. The encouragingly high classification accuracy of our proposal implies that it can efficiently automate COVID-19 detection from radiograph images to provide a fast and reliable evidence of COVID-19 infection in the lung that can complement existing COVID-19 diagnostics modalities. H5 model in Convolutional Neural Networks (CNN) is a new innovation done by us. CNN (Convolutional Neural Network) is a popular NN algorithm and it clearly outperforms Artificial Neural Networks (ANN) and Recurrent Neural Networks (RNN) in this project. Inception V3, ResNet50, MobileNet and Xception [1] are the existing CNN models but are found to be less accurate and more time consuming. In our R&D lab we have developed a new CNN model called the H5 model. It is the best fit after the output is obtained from Haar Cascade Classifiers. A model which was developed for facial detection and distinction is now used for all objects detection with more accuracy focusing on five regions with different pixel Intensity scheme. The encouragingly high classification accuracy of our proposal implies that it can efficiently automate COVID-19 detection from radiograph images to provide a fast and reliable evidence of COVID-19 infection in the lung that can complement existing COVID-19 diagnostics modalities. In our previous paper on CNN we had exhibited one channel output. In this paper we will deploy the designed model onto heroku cloud. We prefer our model to be deployed in the cloud platform, for global access of our AI application.

**Keywords**: Cloud Computing, heroku cloud, Multichannel output with cascading, H5 Convolutional Neural Network model, Convolution Neural Network (CNN) architecture, COVID-19, Severe Acute Respiratory Syndrome corona virus 2 (SARS cov-2), deep learning based chest radiograph classification (DL-CRC), and global access.

## I. INTRODUCTION

The general symptoms of COVID-19 patients are flu-like such as fever, cough, dyspnoea, breathing problem, and viral pneumonia. But these symptoms alone are not significant. There are many cases where individuals are asymptomatic but their chest CT scan and the pathogenic test were COVID-19 positive. So, along with symptoms, positive pathogenic testing and positive CT images/X-Rays of the chest are being used to diagnose the disease. For pathological testing,

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Real- time PCR is being used as a standard diagnostic tool. CT scans and X rays are important for proper real time diagnosis of this deadly disease.

## II.LITERATURE SURVEY

[1] Title: COVIDX-Net: A Framework of Deep Learning Classifiers to Diagnose COVID-19 In X-Ray Iamges. Authors: Ezz El-Din Hemdan, Marwa A. Shouman, Mohamed Esmail Karar, Published Year: 2020

Findings: The aim of this article is to introduce a new deep learning framework; namely COVIDX-Net to assist radiologists to automatically diagnose COVID-19 in X-ray images. Materials and Methods: Due to the lack of public COVID-19 datasets, the study is validated on 50 Chest Xray images with 25 confirmed positive COVID-19 cases. The COVIDX-Net includes seven different architectures of deep convolutional neural network models, such as modified Visual Geometry Group Network (VGG19) and the second version of Google MobileNet. Each deep neural network model is able to analyze the normalized intensities of the X-ray image to classify the patient status either negative or positive COVID-19 case. Results: Experiments and evaluation of the COVIDX-Net have been successfully done based on 80-20% of X-ray images for the model training and testing phases, respectively. The VGG19 and Dense Convolutional Network (DenseNet) models showed a good and similar performance of automated COVID19 classification with f1-scores of 0.89 and 0.91 for normal and COVID-19, respectively. This study demonstrated the useful application of deep learning models to classify COVID-19 in X ray images based on the proposed COVIDX-Net framework. Clinical studies are the next milestone of this research work.

[2] Title: Pneumonia Detection In Covid-19 Patients Using CNN Algorithm Authors: Vishesh S, Nishanth, Bharath, Amith, Published Year: 2020

Findings: The outbreak of corona virus disease in December 2019 in China spread rapidly across all parts of the world by January 2020. The World Health Organization (WHO) termed it as COVID19 and declared it a pandemic on January 30, 2020. Till June 8th, 2020, the number of confirmed cases is around 7 million globally, and the global fatality rate is around 3-4%. Since it is a highly contagious disease and is spreading rapidly; governments of almost all of the affected countries are taking it on priority to isolate infected individuals as early as possible. The general symptoms of COVID19 patients are flu-like such as fever, cough, dyspnea, breathing problem, and viral pneumonia. But these symptoms alone are not significant. There are many cases where individuals are asymptomatic but their chest CT scan and the pathogenic test were COVID-19 positive. So, along with symptoms, positive pathogenic testing and positive CT images/X-Rays of the chest are being used to diagnose the disease. Deep Learning (DL) techniques specifically Convolutional Neural Networks (CNN) has proven successful in medical imaging classification. Four different deep CNN architectures were investigated on images of chest X-Rays for diagnosis of COVID-19. These models have been pre-trained on the train/test database thereby reducing the need for large training sets as they have pre-trained weights. It was observed that CNN based architectures have the potential for diagnosis of COVID-19 disease.

[3] Title: Imaging Modalities for Covid-19 Detection Authors: Di dong, Zencho Tang, Shuowang, Homengliao, Fan Yang, Published Year: 2020

Findings: Most nations had to take measures to react to the sudden and rapid outbreak of COVID-19 within a relatively short period of time. According to, radiology departments have started to focus more on preparedness rather than diagnostic capability, after sufficient knowledge was gathered regarding COVID-19. The study in stated the resemblance of COVID-19 with other diseases caused by other corona virus variants such as the severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). The importance of a tracking the lung condition of a recovering corona virus patient using CT scans was also mentioned in the study. Chest imaging techniques were highlighted to be a crucial technique for detecting COVID-19 by capturing the bilateral nodular and peripheral ground glass opacities in the lung radiograph images.

## III.EXISTING CN MODELS

i. Inception V3: Szegedy et al proposed the Inception architecture in 2014. The original architecture was called GoogleLeNet. All the subsequent versions were called Inception Vn (n is the version number). Batch Normalization was added in Inception V2 as an improvement over Inception V1. In InceptionV3 model factorization methods were introduced as an improvement over V2. [6]

ii. ResNet50: In 2015 He et al proposed ResNet - The Residual Networks architecture. It has 50 convolutional layers with skip connections that help in improving the learning accuracy of the model. Also, it uses global averaging pooling instead of fully connected layers thereby reducing the model size.[7]

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iii. MobileNet: In 2017 another CNN architecture called MobileNet was proposed by Howard et al. In this separable convolution have been arranged depth-wise and they apply the convolution operation on each color channel separately instead of taking them as a whole. The cost of computation gets reduced in this architecture.

iv. Xception: François Chollet developed Xception in 2017. This model can be considered as an improvised version of Inception as modules of Inception have been replaced with depth wise separable convolutions. This latest and accurate model scores upon speed and accuracy.[8]

## IV. H5 MODEL WITH CLOUD COMPUTING

The above CNN models are less responsive and are time consuming during training. Our H5 model created using five regions of a pre-processed image as shown in figure 1. H5 mapping consists of

i. LH Upper
ii. RH Upper
iii. Central
iv. LH Lower
v. RH Lower

Figure 2 shows the imposition of keras H5 model on our assignment. Scientific symbols needs to be suppressed for clarity. An array of right shape needs to be fed into the keras model. The length or number of images you can put into the array is determined by the first position in the shape tuple. Figure 3 shows the architecture of cloud computing in the healthcare sector.

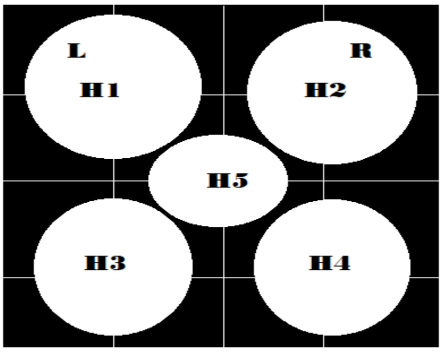


Figure 1 shows H5 region mapping scheme.

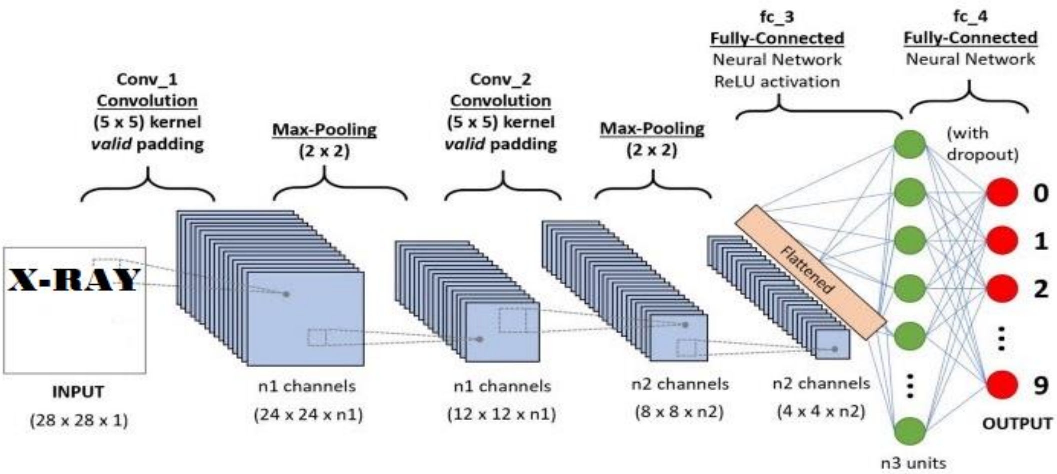


Figure 2 shows the imposition of keras H5 model

  

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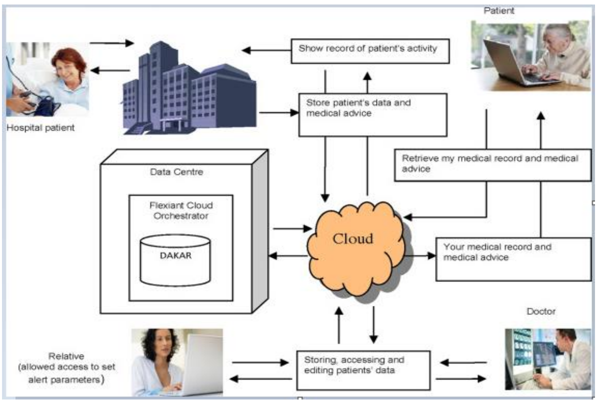


Figure 3 shows cloud computing for medical application

## V. TESTING

System testing involves the design of iterative test cases that validate that the internal program logic is functioning properly, and that program inputs produce valid outputs based on integrated unit tests. All decision branches and internal code flow should be validated. It is the testing of individual software units of the application. Figure 4 shows the table containing different test cases and remarks. Verification was carried out on the system as a whole and multichannel output (channel n) with 9 test cases has proven that it's a possibility to concatenate any number of channels to the cascade classifier. An epoch of 32 may yield better results as compared to an epoch of 10, even though it is time consuming. [9]

| Sl. No. | Testcase | Expected Results | Actual Results | Remarks |
|---|---|---|---|---|
| 1 | Loading the images. | Successfully loaded. | Successfully loaded. | Pass |
| 2 | List the classification of images. | Displays the categories. | Displayed successfully. | Pass |
| 3 | Covert the images to Gray Scale and resize the images. | Successful. | Successful . | Pass |
| 4 | Create and save data and target data files. | Successfully saved. | Successfully saved. | Pass |
| 5 | Load the required libraries. | Successful. | Successful. | Pass |
| 6 | Create the model. | Created successfully. | Created successfully. | Pass |
| 7 | Train and validate the model. | Displays the training and validation results.. | Displayed successfully. | Pass |
| 8 | Evaluate the model. | Displays the accuracy. | Successful. | Pass |
| 9 | Test the model using real time images. | Displays the results. | Successfully displayed. | Pass |

Figure 4 shows the table containing different test cases and remarks.

## VI. RESULTS

After the train-test split the train images are randomly chosen by few instruction sets with a certain random state set. Real-time images are fed to the system and now the trained system takes decisions that are based on the historical image set. As shown in figure 4 training is done on 1057 samples which are obtained randomly by train test split.[9] Validation is carried out on 265 samples. Epoch is fixed to 10 and 1057 samples are evaluated epoch number of times and average training time noted on each step. [10] One can note from figure 4 that the average time taken for training is 90ms and the accuracy is ever increasing which is appreciable as compared to the above models and RNN. Figure 6 shows the validation losses incurred during training. It can be noted that as the epoch value increase and with the increasing sample size the validation loss decreases. The summation of the training loss and validation loss gives the effective loss of our H5 model which is around 2% which can also be reduced by adopting innovative pre-processing techniques. Figure 7 shows the evaluation of the model or real time testing using images captured by the camera or camcorder. Figure 8 shows the array of the image being processed after normalization. Figure 9 shows the UI screen

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deployed on the cloud to select image for prediction of pneumonia. Figure 10 and 11 shows the result of a patient's diagnosis as normal and pneumonia positive respectively by the AI bot.

```
Epoch 1/10
1057/1057 [==============================] - 115s 109ms/step
y: 0.8642
Epoch 2/10
1057/1057 [==============================] - 99s 94ms/step -
0.9170
Epoch 3/10
1057/1057 [==============================] - 95s 90ms/step -
0.9170
Epoch 4/10
1057/1057 [==============================] - 94s 89ms/step -
0.8717
Epoch 5/10
1057/1057 [==============================] - 94s 89ms/step -
0.8868
Epoch 6/10
1057/1057 [==============================] - 94s 89ms/step -
0.9547
Epoch 7/10
1057/1057 [==============================] - 95s 90ms/step -
0.9547
Epoch 8/10
1057/1057 [==============================] - 94s 89ms/step -
0.9736
```

Figure 5 shows the process of training on the samples after train test split and time consumed at each step of training.

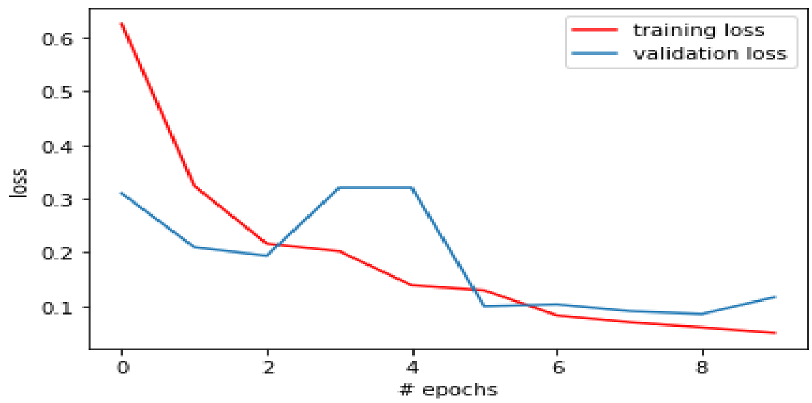


Figure 6 shows the validation losses incurred during training.

```
print(model.evaluate(test_data,test_target))

147/147 [==============================] - 3s 21ms/step
[0.07489856195693113, 0.9727891087532043]
```

Figure 7 shows the evaluation of the model or real time testing using images captured by the camera or camcorder.

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```
array([[-1.        , -1.        , -1.        , ...,
        -1.        , -1.        ],
       [-0.29921257, -0.29133856, -0.28346455, ...,
        -1.        , -1.        ],
       [ 1.007874  ,  1.007874  ,  1.007874  , ...,
        -1.        , -1.        ],
       ...,
       [-0.39370078, -0.11023623,  0.07086611, ...,
        -1.        , -0.992126  ],
       [-0.36220473, -0.04724407, -0.00787401, ...,
        -1.        , -1.        ],
       [-0.79527557, -0.79527557, -0.86614174, ...,
        -1.        , -1.        ]], dtype=float32)
```

Figure 8 shows the array of the image being processed after normalization.

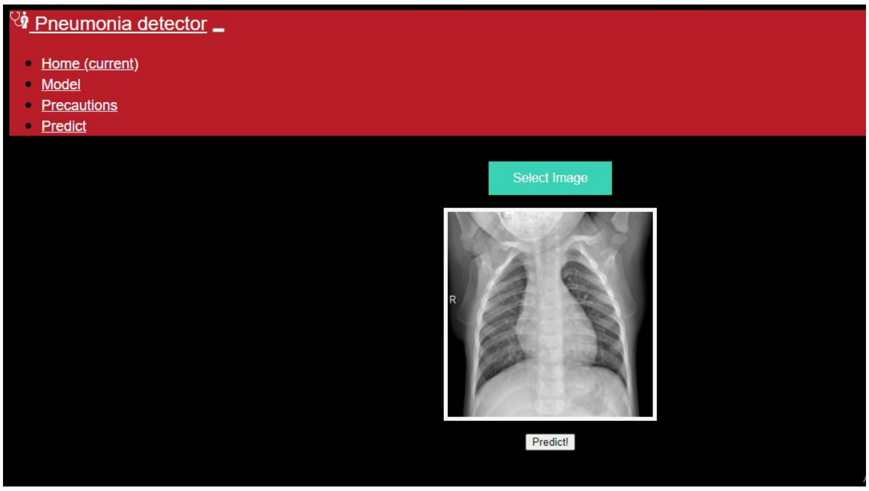


Figure 9 shows the UI screen deployed on the cloud to select image for prediction of pneumonia.

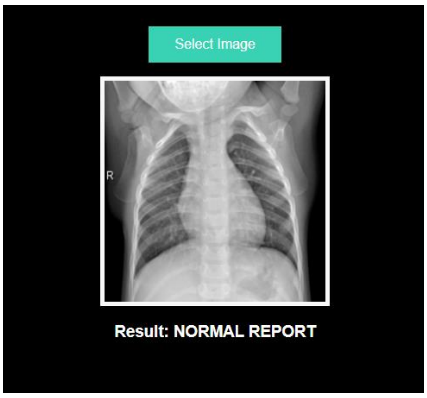


Figure 10 shows the result of a patient’s diagnosis

  

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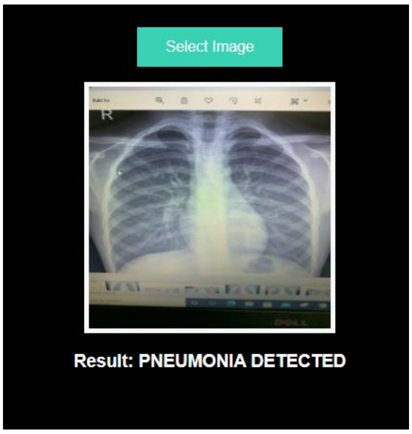


Figure 11 shows the result of a patient's diagnosis as pneumonia positive by the AI bot

## VII. CONCLUSIONS

COVID-19 is a deadly disease if not monitored and treated at the right time. RT-PCRs are not just enough in screening the patient's situation. Since this disease targets the Lungs and causes pneumonia in the affected individual, screening of Lungs is compulsory. Automated models have replaced the traditional methods of screening. CNN is one such algorithm which can detect abnormalities in the chest. Inception V3, ResNet50, MobileNet and Xception are the existing CNN models. But these were found to be less accurate and more time consuming. So at Konigtronics we have developed the H5 model of CNN which focuses on 5 aspects or regions of the target image. The summation of the training loss and validation loss gives the effective loss of our H5 model which is around 2%. Average time taken for training is 90ms and the accuracy is ever increasing which is appreciable at approx 98%. We have deployed the designed model onto heroku cloud. Many real-time X-ray images of COVID-19 affected patients were fed as input and results obtained in seconds.

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## OUR GUIDE

**VISHESH S (BE(TCE), MBA(e-Business))** born on 13th June 1992 hails from Bangalore (Karnataka) and has completed B.E in Telecommunication Engineering from VTU, Belgaum, Karnataka in 2015. He also worked as an intern under Dr. Shivananju BN, former Research Scholar, Department of Instrumentation, IISc, Bangalore. His research interests include Embedded Systems, Wireless Communication, BAN and Medical Electronics. He is also the Founder and Managing Director of the corporate company Konigtronics Private Limited. He has guided over a thousand students/interns/professionals in their research work and projects. He is also the co-author of many International Research Papers. He has recently completed his MBA in e-Business and PG Diploma in International Business. Presently Konigtronics Private Limited has extended its services in the field of Software Engineering and Webpage Designing. Konigtronics also conducts technical and non-technical workshops on various topics. Real estate activities are also carried out under the guidance of Siddesh B S BE (civil). Vishesh S along with his father BS Siddesh has received various awards and applauses from the scientific and entrepreneurial society. He was appointed as the MD of Konigtronics Pvt Ltd (INC. on 9th Jan 2017) at an age of 23 years. His name is indexed in various leading newspapers, magazines, scientific journals and leading websites & entrepreneurial forums. He is also the guide for many international students pursuing their Masters.