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Covid 19 Risk Prediction in Emergency Departments

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ABSTRACT: The epidemic of COVID 19, the confirmed and suspected cases often grow rapidly beyond the capabilities of medical institutions, rapid and accurate diagnosis for patients have become the first priority. The rapid rise in patients with Covid-19 is challenging for healthcare systems all over the globe. With limited testing kits, it is impossible to test with conventional techniques for every patient for the respiratory disease. . Effective screening of infected patients is a crucial step in the battle against Covid-19, with radiological imaging using chest radiography being one of the main screening methods. The current method of detecting disease is done by an expert's opinion and physical analysis, which is time-consuming and costly in the real world. Chest RADIOGRAPHY (X-RAYS) combined with Convolutional Neural Network (CNN) methods have been demonstrated in ARTIFICIAL INTELLIGENCE to detect and diagnose the onset of COVID-19, the disease caused by the Severe Acute Respiratory Syndrome Corona virus 2 (SARS-CoV-2). However, questions remain regarding the accuracy of those methods as they are often challenged by limited datasets, performance legitimacy on imbalanced data, and have their results typically reported without proper confidence intervals. The hyper parameters of the three networks were tuned and their performances were carefully compared. Our results indicate that the **CNN** model outperformed the others, providing the best classification accuracies.

KEYWORDS Covid-19,Convolutional Neural Networks, Chest X-ray images, corona virus, Artificial Intelligence

I. INTRODUCTION

Covid-19 is a severe disease issue where a large number of people lose their lives every day Many scientists are working on these kinds of viruses, and few of them are diagnosed due to the availability of vaccines prepared by them (i.e., Scientists or researchers).Medical imaging is also a method of analyzing and predicting the effects of covid-19 on the human body. In this, healthy people and Covid-19 infected patients can be analyzed in parallel with the help of CT (Computerized Tomography) images and chest X-ray images(CXR). For contributing to an analysis of Covid-19, we collected uploaded data of X-ray images of healthy and covid-19 infected patients from different sources and applied these different models (InceptionV3, Xception,VGG16 and ResNeXt). The analysis of this collected data is done with the help of CNN, a machine learning tool. AI has proven to be useful in medical applications since its inception, and it became widely accepted due to its high prediction and accuracy rates. In the diagnosis stage of COVID-19, AI can be used to recognize patterns medical images taken by X-rays.

DEEP LEARNING

Deep learning is an artificial intelligence (AI) function that imitates the workings of the human brain in processing data and creating patterns for use in decision making. Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. Machine Learning represents a set of algorithms trained on data that make all of this possible.

In traditional machine learning, the learning process is supervised, and the programmer has to be extremely specific when telling the computer what types of things it should be looking for to decide. Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabelled. It is also known as deep neural learning or deep neural network. The advantage of deep learning is the program builds the feature set by itself without supervision. Unsupervised learning is not only faster, but it is usually more accurate.

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DEEP LEARNING METHODS

The most popular deep learning algorithms are Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), Long Short-Term Memory Networks (LSTMs), Stacked Auto-Encoders, Deep Boltzmann Machine (DBM), Deep Belief Networks (DBN). The method that is being used is CNN.

CONVOLUTIONAL NEURAL NETWORKS

Deep Convolutional neural network has recently been applied to image classification with large image datasets. A deep CNN is able to learn basic filters automatically and combine them hierarchically to enable the description of concepts for pattern recognition. However, many deep CNNs have the problems of over fitting and huge processing time. Most data are not separable by linear filters since they are usually distributed on nonlinear manifolds. To enhance model discriminability, the Network In Network (NIN) model was developed. Multilayer Perception (MLP) was created by using a sliding micro neural network to increase the nonlinearity of local patches. The NIN structure can efficiently abstract the quantities of information within the receptive fields. a NIN based network module that can be considered as a modification of inception structure.

In, the pool projection and pooling layer are removed for maintaining the entire feature map size, and a larger kernel filter is added instead. The number of parameters on account of removed dense prediction and pooling is greatly reduced. They added a larger kernel than the original inception structure for not increasing the depth of layers. Their structure is applied to typical image-to-image learning problems, i.e. the problems where the size of input and output are same such as skin detection, semantic segmentation, and compression artifacts reduction. the features came from the feature extraction step need to be consolidated before the network training. We use a different strategy to skip the feature fusion step. The features are separately characterized in the neural networks. We establish two micro neural networks proposed in NIN structure to abstract the data within the receptive field. The MLP is shared among all local receptive fields and without the Softmax layer. Unlike the structure, we divide the input feature maps into two f-maps, One f-map is for periodicity property abstraction, and another is for FRF abstraction.

II. RELATED WORKS

The outbreak of the COVID-19 pandemic caused the death of a large number of people. The possibility of a model over fitting is another concern for larger CNN-based networks when trained with a small datasets. Partially as an effect of a more imbalanced dataset, their reported accuracy was comparatively low, reaching 89.6% . On imbalanced datasets, there is a higher chance that the model may be biased on significant classes and might affect the overall performance of the model**.**

Yuxi Dong and Yuchao gives a survey of diagnosis reports to train a Convolutional Neural Networks [1], the authors use a dataset of 16,569 chest X-ray images with their diagnosis reports to train a CNN model that can automatically generate these diagnoses on new images, to classify each X-ray image into one or more classes. Their preliminary results show that we can predict the disease labels with 82%. In multi-disease detection tasks, they achieve a mean average precision of 0.829.

Heli Harvala et al. gives a survey of Classification Of SARS-CoV-2 Diseases Using Machine Learning And Image Preprocessing Techniques [2]. He introduced the artificial intelligence based automatic covid disease detection and classification for quick and easy detection of disease and then classifying it and performing required remedies to stop the spread of that disease. In this approach he has followed several steps i.e. image collection, image preprocessing, segmentation and classification.

Matthew L et al. gives us the survey of Convalescent plasma therapy for the treatment of patients with COVID-19 [3]**.** In this process blood samples were collected from 52 individuals with a previous laboratory-confirmed SARS-CoV-2 infection.

Shima et al. gives us the survey of Covid-19 Detection Using Machine Learning [4]. This paper makes use of Random Forest in identifying between healthy and diseased person from the data sets created. The proposed paper includes various phases of implementation namely dataset creation, feature extraction, training the classifier and classification. The created datasets of diseased and healthy leaves are collectively trained under Random Forest to classify the diseased and healthy images. For extracting features of an image they used Histogram of an Oriented Gradient (HOG).

M.El-Kenaw y et al. gives us the survey of Feature Selectors for Efficient COVID 19 X-Ray Chest Image [5]. This study has the classification which was tested using a dataset from Kaggle with 5,863 chest X-ray images, and is also tested for a chest X-ray COVID-19 dataset. Methods with two stages to classify different cases from the chest X-ray images based on a (ASSOA) Advanced Squirrel Search Optimization Algorithm.

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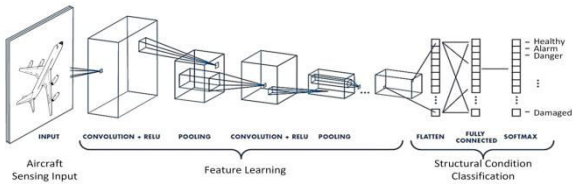
Sadman et al. gives the survey of Deep Learning-Based Chest Radiograph Classification for COVID-19 [6]. The authors' proposed deep learning-based chest radiograph classification (DL-CRC) framework. A deep learning-based predictive analytics approach is employed to propose a smart and automated classification framework for predicting COVID-19, pneumonia, and normal cases. The performance of their customized CNN model is extensively compared with the state-of-the-art CNN architectures.
Rahman and Amith et al. gives the survey of Reliable Tuberculosis Detection Using Chest X-Ray With Deep Learning, Segmentation and Visualization [7]. The paper focuses on the detection of TB using transfer learning based technique of CNNs on the original and segmented lungs in X-ray images. Used the CovidGAN model for augmentation of training dataset with the CNN model for improved detection of COVID-19.

III. PROPOSED WORK

In this work, the idea is to propose an efficient algorithm for Covid Detection which has better robustness and can reduce the risk of information loss. This is confirmed by the performance evaluation to do at the end of the execution of the algorithm. A trained deep learning model based on a convolutional neural network and its architectures like VGG16, takes the image and predicts whether the given image has any presence of covid-19 infection in it or not. The web application provides the same output back to the user.
To overcome existing issues a deep learning model which employs the techniques to extract relevant features related to images of Chest X-rays along with CNN (Convolutional Neural Network) and its architectures like VGG16, ResNet34, with alternate functions in order to detect and identify the disease has been used.
The dataset used here in the proposed method is Covid-19 and Normal Datasets. The basic flow of the proposed model is shown in the Figure 3.2 below. The dataset is split into Train and Test dataset. Images are processed and resized into 128 * 128 (256 * 256 takes time for processing) and converting them to tensors. Validation set is created from 0.3% of the train dataset. Loading the data using Batches and Trying various CNN architecture like, Combination of Multilayer CNN with Linear Layers, VGG16 using Transfer Learning, Resnet34 using Transfer Learning. Workflow of the proposed work as shown in the figure 1.1
After training the model, its performance will be analyzed using metrics like the confusion matrix, the ROC-AUC curve, and the accuracy of training datasets. We then plan to integrate the model to a web-interface by creating an application-program interface (API) using back-end frameworks like Flask or the Django framework. On the front-end of the interface, we have implemented a simple web application for detecting presence of covid-19 from chest x-ray images. The proposed method uses this dataset to perform CNN and its architectures like VGG16 and ResNet34 to detect covid-19. This system improves efficiency and accuracy to 98.4%.



1.1 Workflow of proposed work

IV. METHODOLOGY

DATA DESCRIPTION

The dataset is downloaded from Github repository. This repository contains 5 types of different diseases. It has 'Covid-19 diseases dataset (augmented)', 'Normal patients Dataset (Augmented)', 'test_dataset' folders that are used for testing, training and validating. Patient images in dataset are 'Pneumonia', 'Tuberculosis', 'Covid-19', 'Asthma', 'Normal datasets'. The dataset contains, 9,000 training images and 16,569 testing images.

DATA PREPROCESSING

Data processing involves the splitting of dataset into Train and Test dataset. Images are processed and resized into 128 * 128 as 256 * 256 takes time for processing and converting them to tensors. Tensors are a more generalized representation of vectors interacting in higher dimensions. They have two parameters called dimensions and rank. The inputs, outputs, and transformations within neural networks are all represented using tensors, and as a result, neural network programming utilizes tensors heavily. A tensor is the primary data structure used by neural networks.

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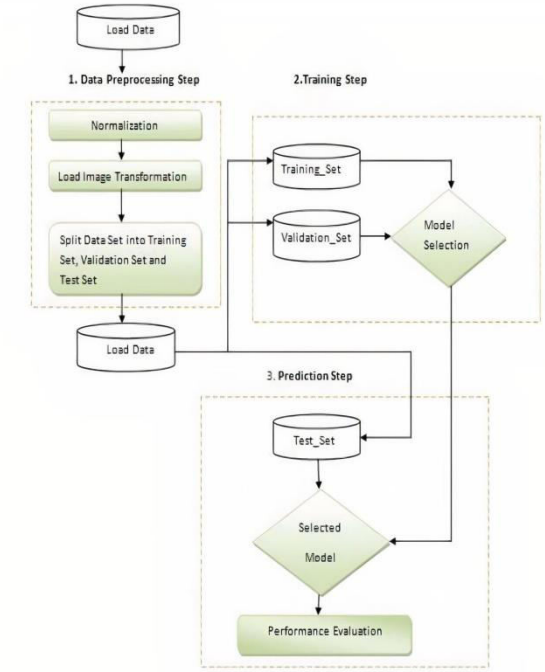
Validation set is created from 0.3% of the training dataset. For loading the data, Batches are used. Batches refer to the number of training examples utilized in one iteration. The reason to use batch is that when you train your deep learning model without splitting it into batches, then your deep learning algorithm (maybe a neural network) has to store errors values for all those 100000 images in the memory and this will cause a great decrease in speed of training. Now the dataset is ready to try various CNN architectures like, Combination of Multilayer CNN with Linear Layers, VGG16 using Transfer Learning, Resnet34 using Transfer Learning.

CNN MODEL

A Convolutional neural network (CNN) is a neural network that has one or more convolutional layers and are used mainly for image processing, classification, segmentation and also for other auto correlated data. A convolution is essentially sliding a filter over the input. A CNN Convolutional neural network is perhaps the most widely applied method for extracting reasonable information from huge datasets. A deep CNN architecture consists of several layers of different types. Typically, it begins with one or more convolutional layers followed by one or more grouping layers, activation layers, and ends with one or more fully connected layers. In the convolution layer, the convolution operation is performed to extract features, and the output is passed to the activation function. The clustering layer is generally used to reduce the size of the feature map and provides robust learning results for the input data. The convolution and pooling layers are then passed through in several steps to obtain global features from the input data. Finally, the extracted characteristics are passed to the fully connected layer where classification is performed in this layer. The development of the model is also carried out, to be implemented at a later stage.



1.2 CNN architecture

In the "Train" learning process in the "dataset", in order to extract from the patterns or characteristics of an image and characterize it using the "CNN" model. So that Covid-19 diseases of the patients can be identified. The CNN architecture is shown in figure 1.2

The convolution layer (CONV); which indicates the locations and strength of detected features in an input (Image). The Layer pooling (POOL); which compresses the information by reducing the size of the intermediate image. The Max Pool which calculates the largest or maximum value in each patch of each feature map. The correction layer (ReLU), with reference to the activation function (Rectified Linear Activation Unit).The Fully Connected Layer (FC), which is a perception-type layer.

CONVOLUTION LAYER

CNN takes an image as an input because images are more than just a pixel values. It distinguishes its objects based on three color planes, and identifies various color spaces. It also measures the image dimensions. The Kernel of CNN works on the basis of the following formula.Image Dimensions = n1 x n2 x 1where n1 = height, n2 = breadth, and 1 = Number of channels.

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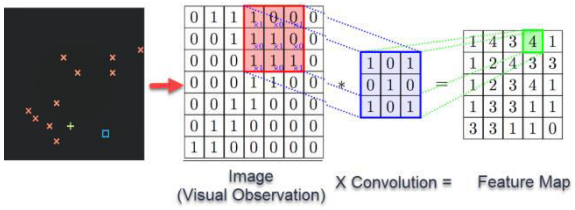


POOLING LAYER

As identical to the recognized layer "Convolutional," the foremost aim of the Pooling layer is essential to decrease the spatial size of the Convolved Feature. So, in short words, it works for decreasing the required computational power for the processing of data by the method of dimensionality reduction. Moreover, it is also beneficial for the extraction of the dominant features, which are basically rotational as well as positional invariant, so the maintenance of the process effectively is needed.

The Convolutional Layer, altogether with the Pooling layer, makes the "i-th layer" of the Convolutional Neural Network. After analyzing the above-described information about the process, executing the model for understanding the features is easy.

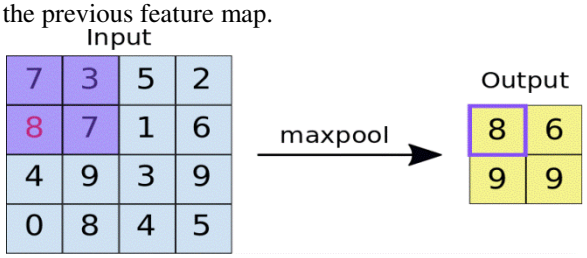
RECTIFIED LINEAR UNIT (ReLU) LAYER.

This layer is an activation function that sets the negative input value to zero, which optimizes and speeds up analyses and training, and helps prevent the gradient from disappearing. Mathematically, this described as:

$$R(x) = max(0, x).$$

MAX POOL

Max pooling is a pooling operation that selects the maximum element from the region of the feature map covered by the filter. Thus, the output after max-pooling layer would be a feature map containing the most prominent features of the previous feature map.

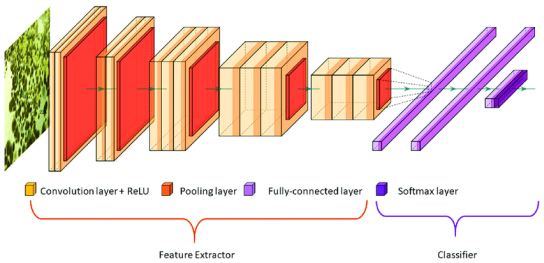


CLASSIFICATION - FULLY CONNECTED LAYER (FC LAYER)

The addition of the FC layer is mostly the easiest way for the learning purpose of the non-linear combinations of the abstract level structures, as it is also revealed by the output of the Convolutional layer. The FC layer provides the space for learning non-linear functions. The project has achieved the task to convert the image output into a specific form of Multi-layer Perception, now it must flatten the output image into a form of a column vector. Over the different eras of epochs, the model is basically succeeded for the distinguishing function between the dominating and low-level features.

VGG16 - CONVOLUTIONAL NETWORK CLASSIFICTION

VGG is a classical Convolutional neural network architecture. It was based on an analysis of how to increase the depth of such networks. The network utilizes small 3 x 3 filters.



1.3 VGG16 architecture

The architecture depicted in VGG Architecture. The input to the cov1 layer is of fixed size 224 x 224 RGB image. The image is passed through a stack of Convolutional (conv.) layers, where the filters were used with a very small receptive

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field: 3×3 (which is the smallest size to capture the notion of left/right, up/down, center). In one of the configurations, it also utilizes 1×1 convolution filters, which can be seen as a linear transformation of the input channels (followed by non-linearity). The convolution stride is fixed to 1 pixel; the spatial padding of conv. layer input is such that the spatial resolution is preserved after convolution, i.e. the padding is 1-pixel for 3×3 conv. layers. Spatial pooling is carried out by five max-pooling layers, which follow some of the conv. layers (not all the conv. layers are followed by max-pooling). Max-pooling is performed over a 2×2 pixel window, with stride 2. It has been used to check the accuracy of the model.

PERFORMANCE EVALUATION

Accuracy

Accuracy is the most intuitive performance measure and it is simply a ratio of correctly predicted observations to the total observations. One may think that, if having high accuracy then the model is best. Yes, accuracy is a great measure but only when you have symmetric datasets. Accuracy has been evaluated using the *Eq.1* .Therefore, you have to look at other parameters to evaluate the performance of your model. The output generated for the CNN, VGG16 and ResNet34 algorithm.

$$\text{Accuracy} = \frac{\text{Number of correct predictions}}{\text{Total number of observations}}$$

VI. RESULT

The dataset, evaluation of the accuracy of detecting disease in patients chest X-rays is done. This Dataset has 9,000 training images and 16,569 testing images. It contains different types of lung diseases of different patients. Diseases: 'Pneumonia', 'Tuberculosis', 'Covid-19', 'Asthma', 'Normal datasets'. The Dataset has been explored by printing the unique plants and finding length of the dataset.

In Data Preprocessing, the dataset of 256*256 pixel length image is converted into 128*128 pixel length as tensors. Tensors are used for better processing. To calculate total Loss and Accuracy at every epoch and plot using matplotlib in PyTorch. Evaluate the model and validation datasets.

The proposed model of CNN shows the accuracy of 96.8% with loss of 41.3% for some model and shows the accuracy of 96.28% and loss of 39.1% for another model. Accuracy of all three architectures have been observed and we are able to obtain a test accuracy of 0.96, a maximum accuracy in CNN model. Similarly test loss is low in CNN model. The accuracy of the CNN algorithm provides a more efficient result. After recognizing the model the data is compared and the specific result is saved . The user will be able to access the user interface, that is the phase where the user will have to upload the image of a X-ray that needs to be predicted.

In order to process the data we have to choose the particular file and click on “Predict Now” .Once the image is recognized it is valuated and result is displayed on the website. After uploading image user can get result of crop name, Disease, Cause of disease and how to prevent the disease.

VI. CONCLUSION

The experimental evaluation of image classification approaches is presented in order to identify COVID19 positive cases from chest X-ray scan images. Moreover, a decision fusion based approach is also proposed, which combines the predictions of each of the individual models, in order to improve the predictive performance.

From the experimentations, it is observed that the proposed approach can achieve very impressive results, with above in terms of every performance metric under consideration, while having a good reduction of the number of accuracy. From the experimental observations, it is clear that out proposed based approaches can potentially have a huge impact on the spread control of by providing fast screening. Using Deep Learning Techniques, a solution that is more feasible and reliable compared to other solutions is brought in . The development of CNN algorithm in this project can be highly beneficial for providing better covid-19 prediction.

VII. FUTURE WORK

In the present system, the doctors can upload the chest X-rays of the patients or a patients can manually capture the chest X-ray images and upload in the webpage. After uploading an image of the chest X-ray, the doctor or a patient will get the details of the uploaded images, whether the patient was infected or not. This is the initial phase, once after successful implementation of the initial phase, this webpage can identify various diseases and it will be fully automated

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to show the accurate remedies for the identified disease. The exact details will be sent to patients mobile number through SMS. Further proceeding spread of Covid-19 disease will be reduced once all the humans consults doctors or any nearby hospitals.

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