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Research Article

DEEP LEARNING ALGORITHMS FOR COVID-19 DATA ANALYTICS

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ABSTRACT: COVID-19 is a viral disease that affects humans very fastly where the death rate also increases day by day. Recently a vaccine for COVID-19 is identified and being used by a particular age of people. There are different types of tests being used to identify whether a person is having a corona or not. Mainly, the lung is being affected by people and unable to breath continuously. For diagnosing lunge related problems, Chest X-ray and chest CT imaging techniques are widely used. Various researches are being conducted to identify corona virus by using chest X-ray images. Still, a substantial chest x-ray is a lower cost process in comparison to chest CT. Deep Learning techniques are being applied for analyzing a large amount of chest x-ray images which could screen the COVID-19.This paper analyzes the various deep learning techniques applied for identifying coronavirus symptoms using chest x ray images. Convolutional Neural Network (CNN) algorithm has achieved 95% accuracy for analyzing COVID 19 and Normal patients.

Keywords : COVID-19,Chest X-ray images, Artificial Intelligence, Machine Learning, Deep Learning, Convolutional Neural Networks(CNN).

1. INTRODUCTION

World Health Organization(WHO) first found a new virus of SARS-CoV-2, that is, COVID-19 on 31 December 2019, following a various group of cases in Wuhan, China[1]. The most common symptoms of COVID-19 are Fever, Dry cough and Fatigue. The symptoms for severe COVID-19 diseases are Shortness of breath, Loss of appetite, Confusion, Persistent pain or pressure in the chest and High temperature (above 38 °C). The most widely used COVID-19 detection technique is real-time polymerase chain reaction (RT-PCR).

The following tests are being used to take sample for diagnosing COVID-19

- Swab Test –swab is used to take a sample from nose or throat
- Nasal aspirate –a saline solution to be injected into nose and a sample is to be obtained with a little suction
- Tracheal aspirate – a thin tube with a torch(bronchoscope) is placed into the mouth to reach the lungs from which a sample is taken.
- Sputum Test – Sputum is thick mucus that's gathered in the lungs and it will come out by cough which could be taken by a cup or a swab where it could be used to get a sample from the nose.
- Blood test –a blood sample is taken from a vein.

The above tests are very accurate and take time to predict the COVID-19. A stand-in approach to detect the disease can be radiography scanning, where chest radiography images can be analyzed to detect the presence of, or the symptoms of the novel coronavirus. X-ray machines are available in most of the hospitals which is cheaper than the CT scan machine. Besides this, X-rays have lower 65 ionizing radiations than CT scan. Artificial Intelligence (AI), is a set of algorithms and intelligence to try to mimic human intelligence, and plays a major role in the healthcare industry[2]. Machine learning is a subset of AI,[3] feeds computer data and uses statistical techniques to get progressively better outcome and deep learning techniques is a subset of ML, where it uses neural networks to simulate human-like decision making. Nowadays ML/DL algorithms are applied for medical data analytics, particularly, chest x ray images for COVID-19 diseases.

Machine Learning (ML) is preferred approach for Speech recognition, Natural language processing, Computer vision, Medical outcomes analysis, Robot control, Computational biology and etc., Table 1 shows the various ML Classifications.

Table 1.Machine Learning (ML) Classification

Supervised ML	Unsupervised ML	Reinforcement ML
• Learns by using labeled data with extra supervision • Calculate outcomes • Regression and classification problems to be solved • Algorithms: Linear Regression, Logistic Regression, SVM, KNN etc. • Example: Risk Evaluation, Forecast Sales	• Trained using unlabelled data without any supervision • Discover underlying patterns • Association and Clustering problems to be solved • Algorithms K – Means, C – Means, Apriori • Example: Recommendation System, Anomaly Detection	• Works on interacting with the environment without any supervision • No predefined data • Series of actions are learned • Exploitation or Exploration problems to be solved • Algorithms: • Self Driving Cars, Gaming, Healthcare • Example : • Q – Learning, SARSA

Conventional ML algorithms could not be useful when working with high dimensional data [4] and also failed to solve crucial problems of AI such as natural language processing ,image recognition etc., Deep learning is used to overcome the curse of high dimensionality problems. Deep learning is a subset of machine learning that could run the inputs by biologically-inspired neural network architecture. The neural networks are having hidden layers where the data is to be processed and allows the machine to go "deep" in its learning. Table 2

shows the various Deep learning algorithms[5] are applied for real time applications such Self driving cars, Health care, Detecting development delay in children, Automatic Machine Translation, Object Classification in Photographs, Automatic Handwriting Generation, ,Automatic Game playing and etc.,

Table 2.Deep Learning (DL) Classification

Supervised Deep Learning Algorithms	**Unsupervised Deep Learning Algorithms**
Feed forward Neural Network (FFNN), Recurrent Neural Network (RNN),Convolutional Neural Network (CNN), Support Vector Machine (SVM)	Auto Encoders (AE) ,Restricted Boltzmann Machines (RBMs), Deep Belief Networks (DBNs), Deep Boltzmann Machines (DBM) and Generative Adversarial Networks (GANs)

2. DEEP LEARNING ALGORITHM BASED COVID 19 DATA ANALYTICS

Doctors can diagnose more quickly about COVID 19 symptoms by automatically analyzing chest X-ray images by using Deep Learning methods which can handle large datasets .Table 3 shows the various author's findings by using deep learning algorithms for COVID 19 data analytics.

Table 3. Deep learning algorithm based COVID 19 Data Analytics

Authors&Year	Images/Data	DL Algorithms	Outcome
Jain et. al.,2021[6]	Chest X-ray scans	Deep Learning based Convolutional Neural Network (CNN) models: Inception V3, Xception, and ResNeXt	97.97% accuracy
Ali Narin et. al.,2020[7]	Chest X-ray radiographs	Five pre-trained Convolutional Neural Network based models (ResNet50, ResNet101, ResNet152, InceptionV3 and Inception-ResNetV2	96.1% accuracy by ResNet50 model
Afshar et al. ,2020[8]	Chest X-ray images	Capsule Networks	95.7 % accuracy
Khan et al.,2020[9]	Chest X-ray images	CoroNet	89.60 % accuracy
Chirag Goel et. al.,2020[10]	Computed tomographic images.	Features extracted from the auto encoder and Gray Level Co-occurence Matrix (GLCM), combined with random forest algorithm	97.78% accuracy

Das et. al.,2020[11]	Chest X-ray images	Deep transfer learning-based approach-Xception model	97.40 % accuracy
Wang et. al.,2020[12]	Chest X-ray images	Deep CNN	98. 9% accuracy
Singh et. al.,2020[13]	Chest X-ray images	Multi-Objective Differential Evolution-Based Convolutional Neural Networks	92.55% accuracy
Sahinbas and Catak [14]	Chest X-ray images	VGG16, VGG19, ResNet, DenseNet, InceptionV3	80 % accuracy
Ucar and Korkmaz [15]	Chest X-ray images	Bayes-SqueezeNet	98.3 % accuracy
Jamil et al. [16]	Chest X-ray images	Deep CNN	93% accuracy

3. EXPERIMENTAL SETUP OF CONVOLUTIONAL NEURAL NETWORKS IN COVID-19 IMAGE ANALYTICS

Convolutional Neural Network(CNN) [17][18] is widely used in various image analytics problems by using various layers . Nowadays, a CNN is used to classify the COVID 19 patients and the Normal Patients. The following steps to be taken to analyze the CNN in COVID 19 analytics in Google colab.

- Import Libraries
- Explore the dataset
- COVID-19/Normal Data Visualization
- COVID-19/Normal Data preprocessing and Augmentation
- Build a Convolutional Neural Network (CNN)
- Compile and Train the Model
- Performance Evaluation
- Prediction on New Data

Figure 1 shows the COVID-19/Normal lungs X-ray images. The dataset is taken from https://github.com/education454/datasets.git ,This dataset consists of train and test images of Chest X rays. The training dataset consists of 545 COVID-19 images and 1266 Normal patient images .The test dataset consists of 167 COVID-19 images and 317 Normal patient images. Table 4 shows the CNN model code in Colab.

Table 4.CNN Model code in Colab

```
model = Sequential()
# add the convolutional layer
# filters, size of filters,padding,activation_function,input_shape
model.add(Conv2D(32,(5,5),padding='SAME',activation='relu',input_shape=(150,150,3)))
# pooling layer
```

```
model.add (MaxPooling2D(pool_size = (2,2)))
# place a dropout layer
model.add(Dropout(0.5))
# add another convolutional layer
model.add(Conv2D(64,(5,5),padding='SAME',activation='relu'))
# pooling layer
model.add(Dropout(0.5))
# place a dropout layer
model.add(Dropout(0.5))

# Flatten layer
model.add(Flatten())
# add a dense layer : amount of nodes, activation
model.add(Dense(256,activation='relu'))
# place a dropout layer
# 0.5 drop out rate is recommended, half input nodes will be dropped at each update
model.add(Dropout(0.5))
model.add(Dense(1,activation='sigmoid'))
model.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 150, 150, 32)	2432
max_pooling2d (MaxPooling2D)	(None, 75, 75, 32)	0
dropout (Dropout)	(None, 75, 75, 32)	0
conv2d_1 (Conv2D)	(None, 75, 75, 64)	51264
dropout_1 (Dropout)	(None, 75, 75, 64)	0
dropout_2 (Dropout)	(None, 75, 75, 64)	0
flatten (Flatten)	(None, 360000)	0
dense (Dense)	(None, 256)	92160256
dropout_3 (Dropout)	(None, 256)	0
dense_1 (Dense)	(None, 1)	257

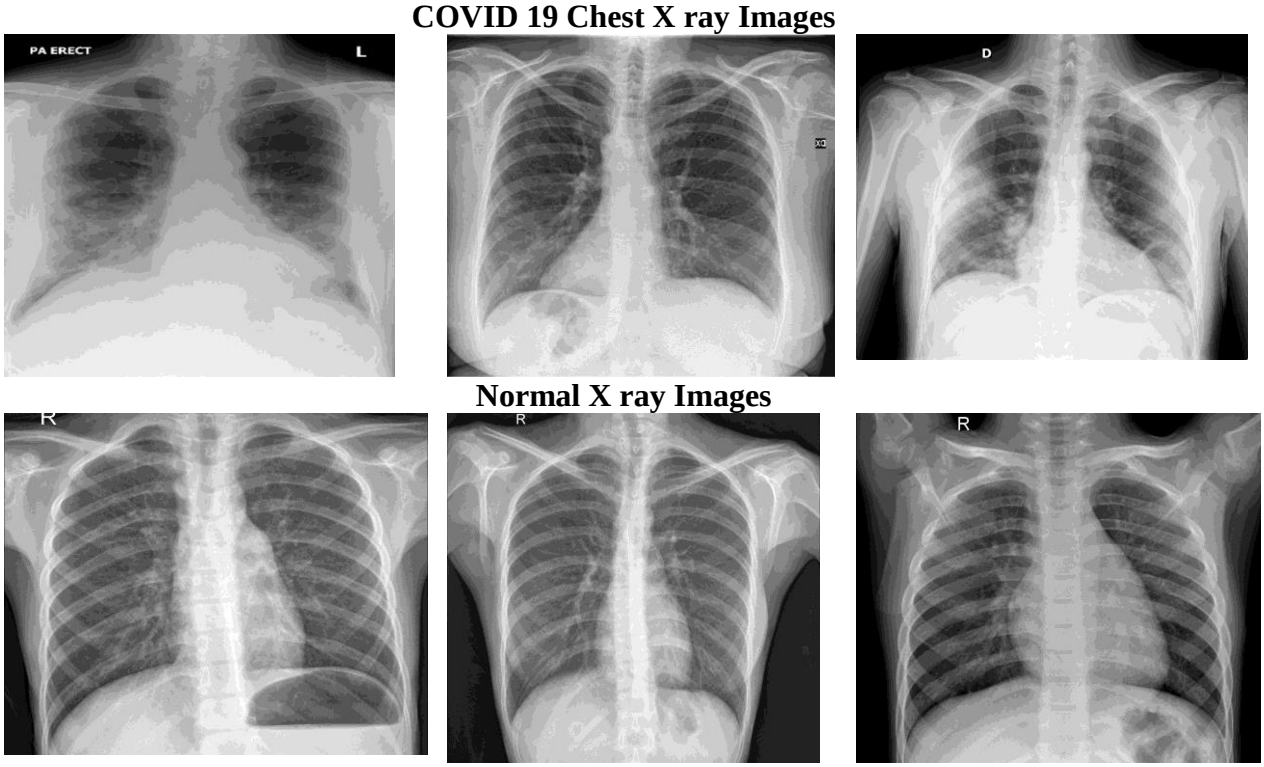

Figure 1. COVID 19 Chest X ray Images/Normal X ray Images

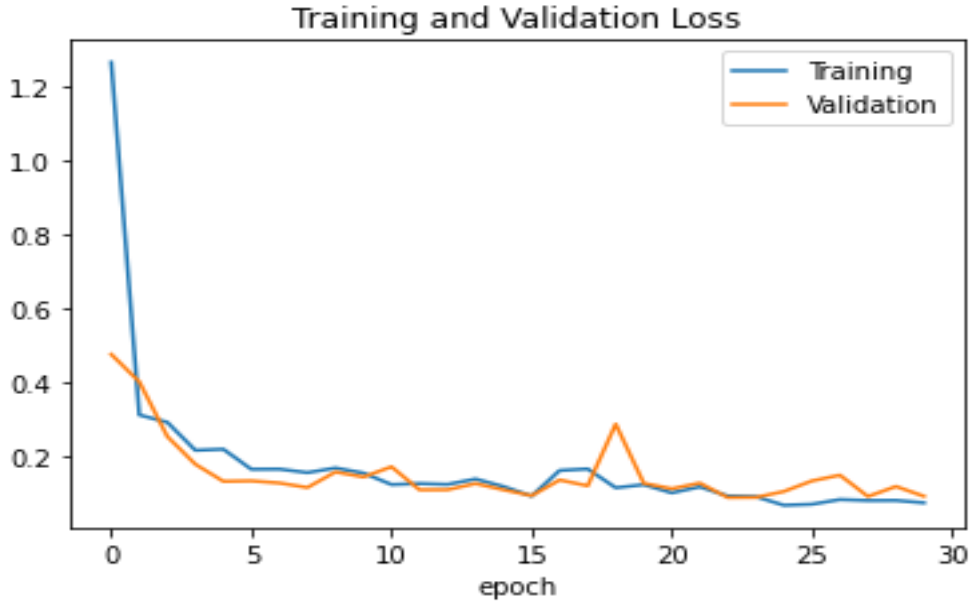

Figure 2 . Training and Validation Loss

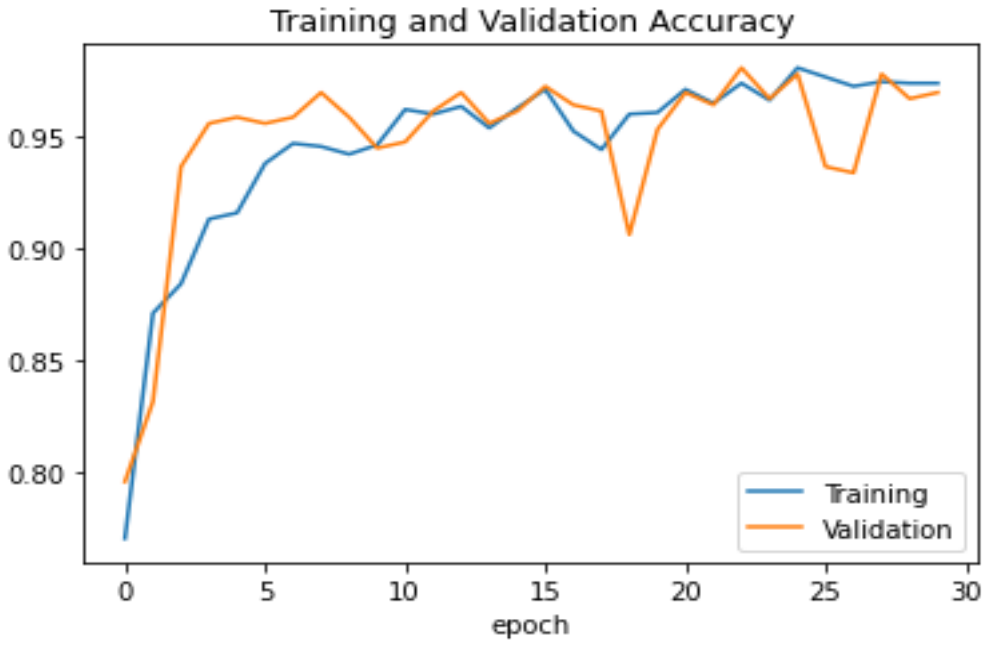

Figure 3 . Training and Validation Accuracy

80% of images are allocated for training and 20% of images are allocated for validation. Figure 2 shows the Training and validation Loss for 30 epochs. Figure 3 shows the Training and validation Accuracy for 30 epochs. From the above analysis, the Convolutional Neural Network (CNN) model provides approximately 95% accuracy for the classification of COVID 19 patients and normal patients.

4. CONCLUSION

This paper analyzes the classification of COVID-19 patients and normal patients. Artificial Intelligence is playing a major role in the healthcare industry by using machine and deep learning algorithms. Machine learning is lacking for high dimensionality of data, where deep learning techniques are used to manage high dimensional data . The automatic analysis of chest X ray images using various deep learning algorithms are increasing nowadays for screening COVID-19 diseases. Convolutional Neural Network (CNN) model provides 95% accuracy for the classification of COVID-19 patients and normal patients. The training time for CNN is to be reduced by combining various Deep learning algorithms in future.

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