Amit Pandey, 2022, 10:1
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

A CNN based Deep Learning Approach for Covid-19 Diagnosis and Prediction in Artificial Intelligence

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Abstract- COVID-19 outbreak has put the whole world in an unprecedented difficult situation bringing life around the world to a frightening halt and claiming thousands of lives. Due to COVID-19's spread in 212 countries and territories and increasing numbers of infected cases and death. It remains a real threat to the public health system. This paper proposed a CNN based deep learning method to predict the seriousness of the decrease in COVID-19 infected patient. Using this novel method, the proposed model can both take in a large number of heterogeneous features, such as census data, intra-county mobility, inter-county mobility, social distancing data, past growth of infection, among others, and learn complex interactions between these features. The simulated results shows that the 77.5% accuracy to detection of covid-19. Precision, recall and Fmeasure values is also optimized and its gives significant better performance.

Keywords- CNN, Covid-19, Machine Learning, Deep learning, AI, Python.

I. INTRODUCTION

The very first infected novel corona virus case (COVID-19) was found in Hubei, China in Dec. 2019. The COVID-19 pandemic has spread over 214 countries and areas in the world, and has significantly affected every aspect of our daily lives.

At the time of writing this article, the numbers of infected cases and deaths still increase significantly and have no sign of a well-controlled situation, e.g., as of 13 July 2020, from a total number of around 13.1 million positive cases, 571,527 deaths were reported in the world.

Motivated by recent advances and applications of artificial intelligence (AI) and big data in various areas, this paper aims at emphasizing their importance in responding to the COVID-19 outbreak and preventing the severe effects of the COVID-19 pandemic. COVID-19 outbreak has put the whole world in an unprecedented difficult situation bringing life around the world to a frightening halt and claiming thousands of lives. Due to COVID-19's spread in 212 countries and territories and increasing numbers of infected cases and death, it remains a real threat to the public health system.

The main advantage of these AI-based platforms is to accelerate the process of diagnosis and treatment of the COVID-19 disease. The most recent related publications and medical reports were investigated with the purpose of choosing inputs and targets of the network that could facilitate reaching a reliable Artificial Neural Network-based tool for challenges associated with COVID-19.

Furthermore, there are some specific inputs for each platform, including various forms of the data, such as clinical data and medical imaging which can improve the performance of the introduced approaches toward the best responses in practical applications. Artificial Intelligence (AI) intent is to facilitate human limits.

It is getting a standpoint on human administrations, filled by the growing availability of restorative clinical data and quick progression of insightful strategies. Motivated by the need to highlight the need for employing AI in battling the COVID-19 Crisis, this

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survey summarizes the current state of AI applications in clinical administrations while battling COVID-19. Furthermore, we highlight the application of Big Data while understanding this virus.

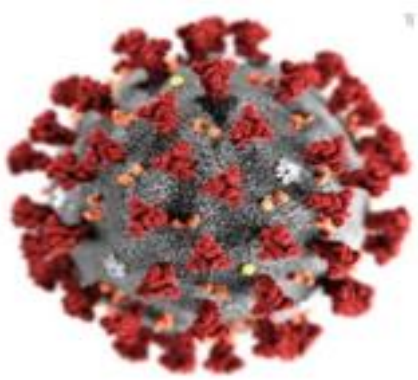

Fig 1. Corona virus.

The overview of various intelligence techniques and methods that can be applied to various types of medical information-based pandemic. We classify the existing AI techniques in clinical data analysis, including neural systems, classical SVM, and edge significant learning. Also, an emphasis has been made on regions that utilize AI-oriented cloud computing in combating various similar viruses to COVID-19.

The unprecedented outbreak of the 2019 novel corona virus, termed as COVID-19 by the World Health Organization (WHO), has placed numerous governments around the world in a precarious position. The impact of the COVID-19 outbreak, earlier witnessed by the citizens of China alone, has now become a matter of grave concern for virtually every country in the world.

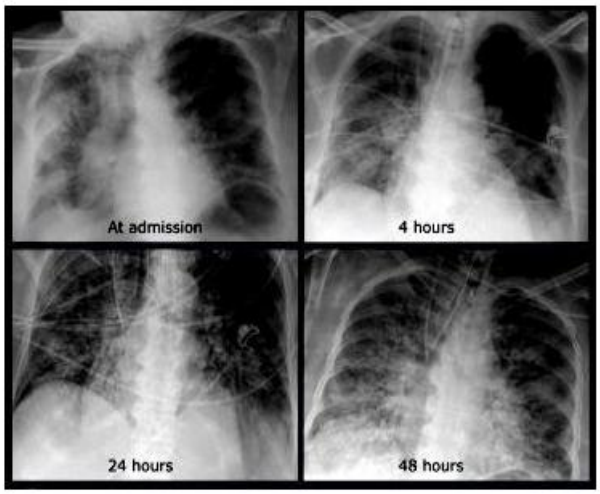

Fig 2. Chest condition due to Covid-19.

The scarcity of resources to endure the COVID-19 outbreak combined with the fear of overburdened healthcare systems has forced a majority of these countries into a state of partial or complete lockdown. The number of laboratory-confirmed corona virus cases has been increasing at an alarming rate throughout the world, with reportedly more than 3 million confirmed cases as of 30 April 2020.

Adding to these woes, numerous false reports, misinformation, and unsolicited fears in regards to corona virus, is being circulated regularly since the outbreak of the COVID-19.

The pandemic of corona virus disease 2019 (COVID-19) is spreading all over the world. Medical imaging such as X-ray and computed tomography (CT) plays an essential role in the global fight against COVID-19, whereas the recently emerging artificial intelligence (AI) technologies further strengthen the power of the imaging tools and help medical specialists. We hereby review the rapid responses in the community of medical imaging (empowered by AI) toward COVID-19.

For example, AI-empowered image acquisition can significantly help automate the scanning procedure and also reshape the workflow with minimal contact to patients, providing the best protection to the imaging technicians.

II. BACKGROUND

M. Jamshidi et al.,[1] This work renders a response to combat the virus through Artificial Intelligence (AI). Some Deep Learning (DL) methods have been illustrated to reach this goal, including Generative Adversarial Networks (GANs), Extreme Learning Machine (ELM), and Long/Short Term Memory (LSTM). It delineates an integrated bioinformatics approach in which different aspects of information from a continuum of structured and unstructured data sources are put together to form the user-friendly platforms for physicians and researchers.

A. A. Hussain et al.,[2] This survey study is an attempt to benefit medical practitioners and medical researchers in overpowering their faced difficulties while handling COVID-19 big data. The investigated techniques put forth advances in medical data analysis with an exactness of up to 90%. We further

end up with a detailed discussion about how AI implementation can be a huge advantage in combating various similar viruses.

V. Chamola et al.,[3] presents a response to such acts, we draw on various reliable sources to present a detailed review of all the major aspects associated with the COVID-19 pandemic. In addition to the direct health implications associated with the outbreak of COVID-19, this study highlights its impact on the global economy. In drawing things to a close, we explore the use of technologies such as the Internet of Things (IoT), Unmanned Aerial Vehicles (UAVs), blockchain, Artificial Intelligence (AI), and 5G, among others, to help mitigate the impact of COVID-19 outbreak.

F. Shi et al.,[4] AI can improve work efficiency by accurate delineation of infections in X-ray and CT images, facilitating subsequent quantification. Moreover, the computer-aided platforms help radiologists make clinical decisions, i.e., for disease diagnosis, tracking, and prognosis. In this review paper, we thus cover the entire pipeline of medical imaging and analysis techniques involved with COVID-19, including image acquisition, segmentation, diagnosis, and follow-up. We particularly focus on the integration of AI with X-ray and CT, both of which are widely used in the frontline hospitals, in order to depict the latest progress of medical imaging and radiology fighting against COVID-19.

Q. Pham et al.,[5] present an overview of AI and big data, then identify the applications aimed at fighting against COVID-19, next highlight challenges and issues associated with state-of-the-art solutions, and finally come up with recommendations for the communications to effectively control the COVID-19 situation. It is expected that this paper provides researchers and communities with new insights into the ways AI and big data improve the COVID-19 situation, and drives further studies in stopping the COVID-19 outbreak.

N. Zheng et al.,[6] presents, a hybrid artificial-intelligence (AI) model is proposed for COVID-19 prediction. First, as traditional epidemic models treat all individuals with corona virus as having the same infection rate, an improved susceptible-infected (ISI) model is proposed to estimate the variety of the infection rates for analyzing the transmission laws and development trend. Second, considering the effects of prevention and control measures and the increase of the public's prevention awareness, the natural language processing (NLP) module and the long short-term memory (LSTM) network are embedded into the ISI model to build the hybrid AI model for COVID-19 prediction. The experimental results on the epidemic data of several typical provinces and cities in China show that individuals with corona virus have a higher infection rate within the third to eighth days after they were infected, which is more in line with the actual transmission laws of the epidemic.

R. Sethi et al.,[7] A diagnosis recommender system that can assist the doctor to examine the lung images of the patients will reduce the diagnostic burden of the doctor. Deep learning techniques specifically Convolution 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 Image Net 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.

Y. Oh et al.,[8] Under the global pandemic of COVID-19, the use of artificial intelligence to analyze chest X-ray (CXR) image for COVID-19 diagnosis and patient triage is becoming important. Unfortunately, due to the emergent nature of the COVID-19 pandemic, a systematic collection of CXR data set for deep neural network training is difficult. To address this problem, here we propose a patch-based convolutional neural network approach with a relatively small number of trainable parameters for COVID- 19 diagnosis. The proposed method is inspired by our statistical analysis of the potential imaging biomarkers of the CXR radiographs. Experimental results show that our method achieves state-of-the-art performance and provides clinically interpretable saliency maps, which are useful for COVID-19 diagnosis and patient triage.

M. U. Ashraf et al.,[9] presents a smart edge surveillance system that is effective in remote monitoring, advance warning and detection of a person's fever, heart beat rate, cardiac conditions and some of the radiological features to detect the

infected (suspicious) person using wearable smart gadgets. The proposed framework provides a continually updated map/pattern of communication chain of COVID-19 infected persons that may span around in our national community.

The health and societal impact of suggested research is to help public health authorities, researchers and clinicians contain and manage this disease through smart edge surveillance systems. The proposed model will help to detect and track the contagious person. Moreover, it will also keep the patient's data record for analysis and decision making using edge computing.

D. Dong et al.,[10] presents the imaging characteristics and computing models that have been applied for the management of COVID-19. CT, positron emission tomography - CT (PET/CT), lung ultrasound, and magnetic resonance imaging (MRI) have been used for detection, treatment, and follow-up. The quantitative analysis of imaging data using artificial intelligence (AI) is also explored.

Our findings indicate that typical imaging characteristics and their changes can play crucial roles in the detection and management of COVID-19. In addition, AI or other quantitative image analysis methods are urgently needed to maximize the value of imaging in the management of COVID-19.

M. Sethi et al.,[11] presents sole focus is to analyze the emotions expressed by people using social media such as Twitter etc. Accumulating and studying the concerning tweets will provide aid to elicitate the real emotions during this hard time. The goal of this study is to present a domain-specific approach to understand sentiments manifested within people around the globe regarding this situation. In order to attain this, corona-specific tweets are acquired from twitter platform. After gathering the tweets, they are labelled and a model is developed which is effective for detecting the actual sentiment behind a tweet related to COVID-19.

The substantial assessments are performed in bi-class and multi-class setting over n-gram feature set along with cross-dataset evaluation of different machine learning techniques in order to develop the model. Our experiments reveal that the proposed model performs well in perceiving the perception of people about COVID-19 with a maximum accuracy of about 93%.

A. Ramchandani et al.,[12] presents a deep learning model to forecast the range of increase in COVID-19 infected cases in future days and we present a novel method to compute equidimensional representations of multivariate time series and multivariate spatial time series data. Using this novel method, the proposed model can both take in a large number of heterogeneous features, such as census data, intra-county mobility, inter-county mobility, social distancing data, past growth of infection, among others, and learn complex interactions between these features.

Using data collected from various sources, we estimate the range of increase in infected cases seven days into the future for all U.S. counties. In addition, we use the model to identify the most influential features for prediction of the growth of infection. We also analyze pairs of features and estimate the amount of observed second-order interaction between them.

During the literature review the following points come out-

- This justifies how and to what extent Artificial Intelligence (AI) could be crucial in developing and upgrading health care systems on a global scale. AI has been recently attracted increasing research efforts towards solving the complex issues in a number of fields, including engineering, medicine, economy, and psychology.
- Appropriating AI techniques to deal with COVID-19 related issues can the void between AI-based methods and medical approaches and treatments.
- AI specialists' use of AI platforms can help in making connections between various parameters and speed up the processes to obtain optimum results.

III. PROPOSED METHODOLOGY

The dataset where three conventional machine learning algorithms, i.e., Naïve Bayesian (NB), K-nearest neighbor (KNN), and support vector machine (SVM) algorithm to predict the risk of the disease. CNN-based Unimodal Disease Risk Prediction (CNN-UDRP) Algorithm:

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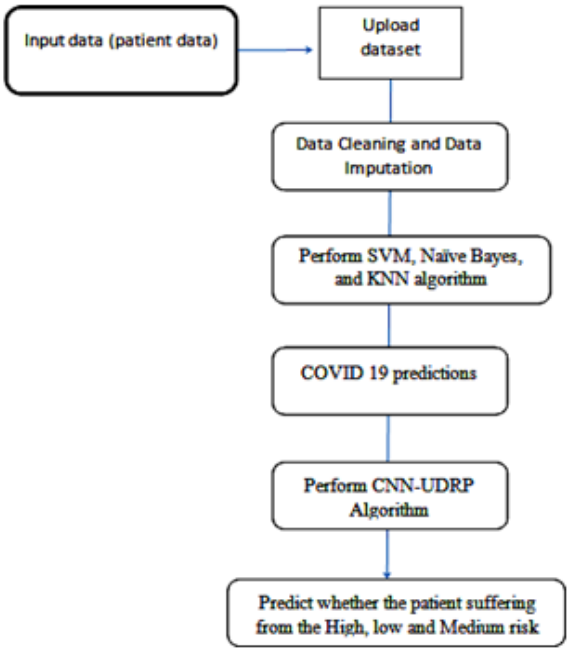

Fig 3. Flow Chart.

The processing of medical image data, CNN-based unimodal disease risk prediction (CNN-UDRP) algorithm is utilized and is divided into the following steps:

- Representation of image data.
- Convolution layer of the image CNN: two words are choosing from front and back of each vector.
- Pool layer of image CNN: The role of every pixel in the image is not completely equal, by maximum pooling the elements are choose which play a key role in the image.
- Full connection layer of image CNN: The pooling layer connected with a fully connected neural network.
- CNN classifier: The connection layer links to a classifier, a softmax classifier is choose.
- CNN-based Multimodal Disease Risk Prediction (CNN-MDRP) Algorithm: The CNN-UDRP only uses the image data to predict whether the patient is at high-risk of the chronic disease. For structured and unstructured image data, a CNN-UDRP algorithm is designed.

IV. SIMULATIONS RESULTS

The implementation of the proposed algorithm is done over python spyder 3.6. The sklearn, numpy, pandas, matplotlib, pyplot, seaborn, os library helps us to use the functions available in spyder environment for various methods like support vector, random forest, naive bayes, CNN etc.

(a) (b)

Fig 4. Seriousness of decease (a) Normal lungs detected (b) Pneumonia lungs detected

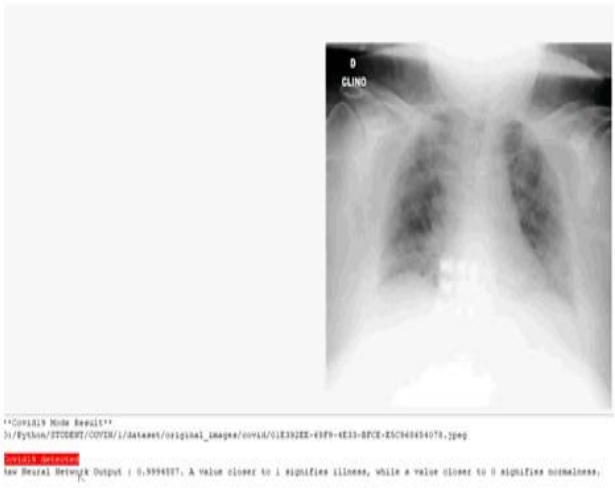

Fig 5. Covid-19 Detected.

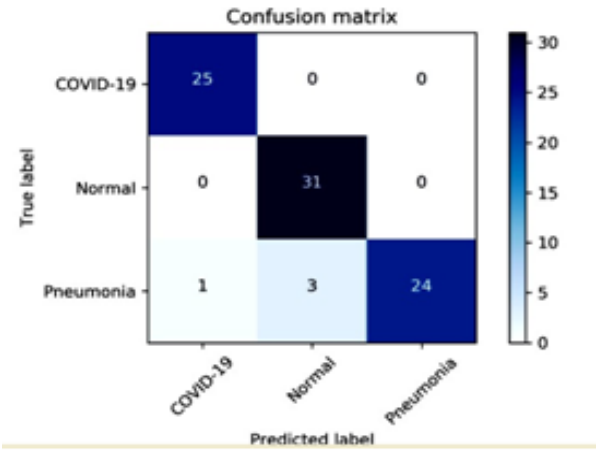

Fig 6. Confusion matrix.

Figure 6 is showing the confusion matrix of proposed approach for the prediction. It is a tabular summary of the number of correct and incorrect predictions made by a classifier. It can be used to evaluate the performance of a classification model through the calculation of performance metrics like accuracy, precision, recall, and F1-score.

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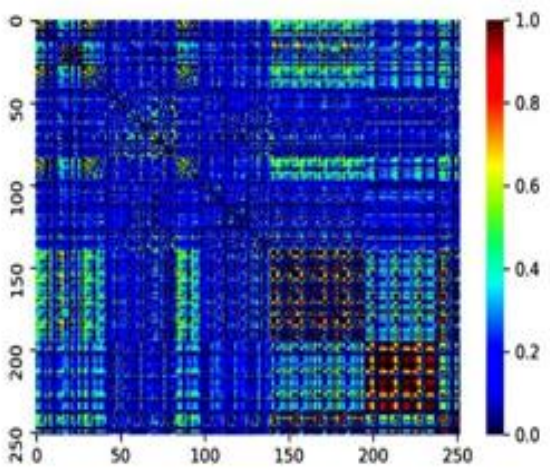
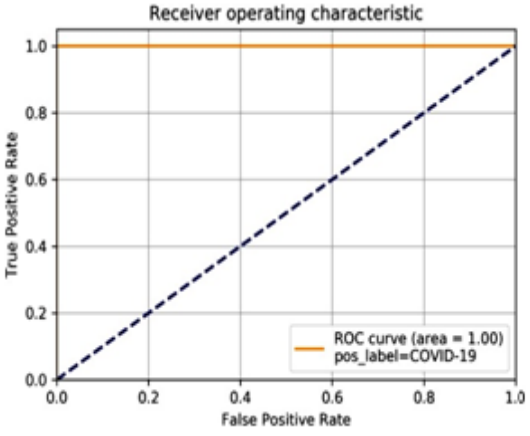
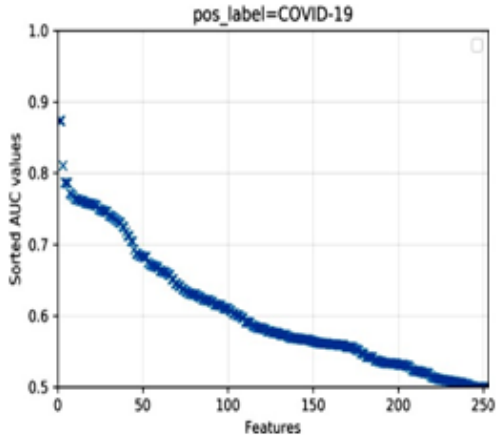


Fig 7. Correlation map.

Figure 7 is showing the correlation matrix, it is a table showing correlation coefficients between variables. Each cell in the table shows the correlation between two variables. A correlation matrix is used to summarize data, as an input into a more advanced analysis, and as a diagnostic for advanced analyses.



(a)



(b)

Fig 8. (a) ROC Curve (b) AUC curve.

Figure 8 is showing the Receiver Operating Characteristic (ROC) curves and area under the curve (AUC). Roc shows the typically feature true positive rate on the Y axis, and false positive rate on the X axis. This means that the top left corner of the plot is the "ideal" point and a false positive rate of zero, and a true positive rate of one. This is not very realistic, but it does mean that a larger area under the curve (AUC) is usually better.

Table 1. Simulation Results.

Sr. No.	Parameters	Proposed Approach
1	Accuracy	77.5%
2	Classification error	22.5%
3	Precision	73.91%
4	Recall	85%
5	F-measure	79.06%
6	Specificity	70%

V. CONCLUSION

The paper proposed an efficient approach based on Deep Learning for Covid-19 Diagnosis and Prediction. The simulation results achieve the overall accuracy is 77.5%, classification error is 22.5%.

The value of precision is 73.91%, recall is 85%, f-measure is 79.06% and specificity is 70%. The simulation results show the overall improvement in performance parameters than existing approach.

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