IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

SARS-CoV-2 COVID 19 Screening with Machine Learning Using Clinical Analysis Parameters

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Abstract: **An unexpected pandemic known as COVID-19 struck the entire world in the year 2020. The lack of a cure has spurred research into all fields to address it. The discovery of techniques for the diagnosis, detection, and prediction of COVID-19 instances is a major contribution to computer science. The most popular methods in this field are data science and machine learning (ML). This document provides a summary of over 160 ML-based strategies created to tackle COVID-19. These sources include Elsevier, Springer, ArXiv, MedRxiv, and IEEE Xplore, among others. They are examined and divided into two groups: techniques based on supervised learning and those based on deep learning. The ML algorithm used in each category is described, along with a list of the parameters that were applied. The settings for each algorithm's parameters are compiled in several tables. They comprise the nature of the examined data (text data, X-ray pictures, CT images, time series, clinical data, etc.), the type of the addressed problem (detection, diagnosis, or detection), and the evaluated metrics (accuracy, precision, sensitivity, specificity, F1-Score, and AUC). The study explores the data gathered and offers some statistics that paint a picture of the current state of the art. According to the results, 79% of cases include deep learning, 65% of which are based on convolutional neural networks (CNN), and 17% employ specialised CNN. On the other hand, only Random Forest, (SVM), and Regression algorithms are used, and supervised learning is only present in 16% of the approaches that were assessed.**

Index Terms **– COVID-19 detection, Machine learning, Artificial intelligence, CNN, SVM, Random Forest.**

INTRODUCTION

COVID-19 is one of the most upsetting calamities of the twenty-first century, is brought on by the coronavirus 2 that causes severe acute respiratory syndrome (SARS-CoV-2). Numerous nations' economies and health systems have been harmed. Data from the World Health Organization (WHO) show that as of September 14, 2021, there had been 225,024,781 confirmed cases of COVID19, with 4,636,153 deaths. It is asserted that direct interactions and respiratory droplets are the main methods of SARS-CoV-2 transmission between people. On the other hand, the infection's incubation period is thought to last between 2 and 14 days. The main intervention being employed aids in managing it and stopping the spread of COVID-19. Studies on clinical forms also show that the population and the age categories with the highest infection rates contain asymptomatic carriers. There has been a significant amount of research done across several disciplines to find a solution after almost a year in this situation. Researchers in computer science are called upon to lend a hand. The visual representation of data is one of the first recognised contributions. The latter was displayed in graphs and/or maps, enabling i) a more accurate tracking of the viruses spread across the world in general and country by country in particular. ii) Better monitor the pandemic's spread over time; iii) calculate the number of confirmed cases and fatalities with greater accuracy.

The capacity to categorise people based on whether or not they are affected is the second area where AI is advantageous. Finally, AI provides the capability to forecast potential future contaminations. Machine Learning (ML), which is frequently mistaken with AI, is specifically employed for this purpose. Beyond the various machine learning (ML) techniques, neural networks (NN) are one of the most frequently employed to address practical issues, leading to the development of deep learning (DL). When there are vast datasets available and the data is complicated, as there are with COVID-19, deep learning is very well suited. The current paper provides an overview of the Machine Learning studies conducted to manage COVID-19 data in this context.

All publications in this topic that meet the following criteria are retained:

- Are published in scholarly journals;
- Propose new COVID-19-addressing algorithms;
- Have more than four pages;
- Are written in English;
- Represent complete versions where multiple are available.
- Don't mention the statistical tests that were performed to determine the significance of the data that were given.
- Don't provide specifics about where their data sets came from.

The outcome is outstanding. Since February 2020, a number of publications have been published in this field each month. China and India appear to have the most COVID-19 publications overall. However, a large number of other nations displayed significant activity in terms of contributions. Given how the crisis affects the entire planet, this is to be expected. In this study, the surveyed methodologies are organised into categories using machine learning. Techniques used in the various ideas to circumvent COVID19 are indicated in yellow. We demonstrate how Convolutional Neural Networks (CNN), which enables Deep Learning, constitutes the foundation of the majority of them. Nearly half of these methods make use of X-ray pictures. However, a variety of additional data sources are employed in varying amounts.

I. LITERATURE REVIEW

Traditional definitions of artificial intelligence (AI) are thought to be inadequate. It can mimic human behaviour with consciousness, sensitivity, and spirit as a result of being more robust. The advent of machine learning (ML) provided the means through which this goal may be moved closer to realisation. Machine learning is an area of artificial intelligence that, by definition, focuses on enabling computers to learn without explicit programming. It is built on the idea of using algorithms that are fed by a lot of data to replicate behaviour. The algorithm builds a model and learns which choice to make in a variety of circumstances. So, depending on the circumstance, the machine can automate the duties.

- **Supervised Learning:** It is a type of artificial intelligence that uses machine learning. The concept is to "guide" the algorithm's learning process using samples of expected results that have already been labelled. After then, artificial intelligence picks up new information from each example and modifies its settings to close the discrepancy between actual and expected results. In order to generalise learning with the goal of predicting the outcome of new situations, the margin of error is hence decreased across the training sessions. If the labels resemble discrete classes, the result is referred to be classification, and if continuous quantities, it is referred to as regression.
- **Support Vector Machine (SVM):** It is a type of artificial intelligence that uses machine learning. The concept is to "guide" the algorithm's learning process using samples of expected results that have already been labelled. After then, artificial intelligence picks up new information from each example and modifies its settings to close the discrepancy between actual and expected results. In order to generalise learning with the goal of predicting the outcome of new situations, the margin of error is hence decreased across the training sessions. If the labels resemble discrete classes, the result is referred to be classification, and if continuous quantities, it is referred to as regression.
- **Decision Tree:** An algorithm called a decision tree aims to arrange people into groups that are as similar to one another as feasible in terms of the variable that needs to be predicted. The algorithm's output is a tree that shows the hierarchical connections between the variables. By selecting the explanatory variable that allows for the best individual separation, a subpopulation of people is obtained at each iteration of an iterative procedure. When no more splits are possible, the algorithm terminates.

- **Random Forest Algorithms:** The Random Forest Algorithms are techniques that offer classification and regression predictive models. They are made up of numerous Decision Tree blocks that are utilised as separate predictors. The basic idea behind the method is that multiple predictors are developed, and their various predictions are pooled, rather than attempting to obtain an optimum method all at once. The class with the highest votes is the one that is ultimately predicted.
- **Artificial Neural Network (ANN):** Popular Supervised classification algorithm Artificial Neural Networks attempts to replicate how the human brain functions. When there is a large amount of labelled training data with numerous characteristics, it is frequently used. The network derives a score (or probability) to belong to each class given the input. The class with the highest score is the one that was given to the input object. A system made up of neurons is known as a neural network. It is separated into a number of interconnected levels where the input of one layer is the output of another. Based on the computation of a linear function from the layer weights and an activation function, the final score is determined.
- **Unsupervised learning:** Unsupervised learning is a sort of self-organized learning that builds models from training datasets that are not labelled (unlike Supervised Learning). Two techniques are used in unsupervised learning. The first is clustering, which is the collection of related data in uniform groupings. It is carried out by utilising one of the numerous clustering techniques already in use, such as K-means, hierarchical clustering, hidden Markova models, etc. The second technique involves reducing the number of features in high-dimensional data, which is known as dimensionality reduction. The goal is to identify new features and the best linear transformation that represents the most data points with the least amount of information loss.
- **Deep Learning:** Deep Learning is a subfield of artificial intelligence that focuses on building massive neural networks with many hidden layers that can make choices using machine learning models. In fact, it has been found that the number of neuronal layers significantly affects the calibre of the outcomes. Additional than ANN, there are other deep learning algorithms. The ones that are most frequently utilised and used in the context of COVID-19 are defined below.
- **Convolutional Neural Network (CNN):** Convolutional Neural Networks, often known as ConvNets, are a type of ANN used in Deep Learning that can classify information from the most basic to the most complex. They are made up of a multilayer stack of neurons and mathematical operations with a number of programmable parameters that pre-process small amounts of data. First convolutional layers are what define convolutional networks (usually one to three). They look for signs of an abstract and fundamental pattern in a thing. This data can be used by subsequent layers to categorise and recognise items in relation to one another.

II. PROPOSED SCHEME:

Overview of Machine Learning approaches used to combat COVID-19

Supervised Learning:

For the detection and categorization of COVID-19 instances, we used the Support Vector Machine (SVM) model. They employed clinical data, blood test results, and urine test results in their work to validate the performance of SVM. Simulated results showed that the SVM model was effective by reaching accuracy, sensitivity, and specificity values of 81.48%, 83.33%, and 100%, respectively. For the purpose of identifying COVID-19-infected individuals from X-ray pictures, a novel method based on the hybridization of SVM with Multi-Level Thresholding was put out. With the help of 40 contrast-enhanced lungs X-ray images—15 normal and 25 with COVID-19—the performance of the hybrid technique was assessed. In a similar piece of work, we proposed a combined technique for COVID19 detection from chest X-ray images that integrated SVM with 13 pre-trained CNN models.

With an average classification accuracy of 95.33%, experimental data demonstrated that ResNet50 paired with SVM beats CCN models combined with SVM. In order to predict COVID-19 patients with severe/critical symptoms, we used the SVM model. To verify the effectiveness of the SVM model, 220 laboratory observation records and 336 instances of COVID-19-infected patients separated into training and testing datasets were used. The SVM model achieves an Area Under Curve (AUC) of 0.9996 and 0.9757 in the training and testing datasets, respectively, according to simulation findings. For the automatic detection of COVID-19 cases, we used four machine learning techniques (SVM with CNN, Extreme Learning Machine (ELM), and Online

Sequential ELM (OS-ELM)). The effectiveness of the suggested methods was evaluated using datasets including 702 CT scan pictures. For the prediction of COVID-19 instances, we suggested Least Square-SVM (LS-SVM) and Autoregressive Integrated Moving Average (ARIMA). The suggested models were validated using a dataset of COVID19 confirmed cases that was gathered from five of the most impacted nations. By achieving an accuracy of 80%, it was shown that the LS-SVM model surpasses the ARIMA model.

We used machine learning techniques like SVM, Decision tree (DT), and KNN to automatically identify COVID-19 positive cases. A public COVID19 radiology database separated into training and test sets with 70% and 30% rates, respectively, was used to validate the performance of the suggested techniques. For a quick diagnosis of COVID-19, we employed SVM with Naive Bayes (NB), Gradient boosting decision tree (GBDT), AdaBoost, CNN, and Multilayer perceptron (MLP). SVM beats other machine learning algorithms, gaining an average accuracy, precision, sensitivity, and F1 score of 99.20%, 98.19%, 100%, and 99.0%, respectively, on a dataset of 980 CT scan pictures (430 with COVID-19 and 550 normal).

Random Forest Algorithm:

For the diagnosis of COVID-19, we suggested the infection Size Aware Random Forest approach (iSARF). To evaluate the effectiveness of iSARF, a dataset of 1020 CT scans (1658 with COVID-19 and 1027 with pneumonia) was employed. By producing a sensitivity of 90.7%, specificity of 83.30%, and accuracy of 87.90% during fivefold cross-validation, simulation results showed that iSARF offers good performance. For the purpose of predicting COVID-19 illness severity, the RF model and AdaBoost algorithm were merged. Based on geographic, travel, health, and demographic information from COVID-19 patients, the effectiveness of the enhanced RF model was assessed. On the used dataset, the boosted RF model yields an accuracy of 94% and an F1-Score of 86%.

The detection of COVID19-positive patients was proposed using seven machine learning techniques: Random Forest, Logistic Regression, KNN, Decision Tree, Extremely Randomized Trees, Naive Bayes, and SVM. The simulation used routine blood tests taken from 279 individuals, and the results showed that the Random Forest algorithm was feasible and effective by reaching accuracy, precision, sensitivity, specificity, and AUC of 82%, 83%, 92%, 65%, and 84%, respectively.

Deep Learning Approaches:

The most widely used strategy for identifying, forecasting, and diagnosing COVID-19 is based on Deep Learning and its various methodologies. We list the approaches we've discovered in relation to the categorization below:

Convolutional Neural Network (CNN):

For the purpose of diagnosing COVID-19 in CT scan pictures, we presented the Residual Network34 (ResNet34) deep CNN model. Using CT scan images obtained from 99 patients (55 with usual viral pneumonia and 44 with COVID19), the efficacy of ResNet34 was verified. ResNet34 achieved an overall accuracy of 73.10%, a specificity of 67%, and a sensitivity of 74%, according to simulation data. For the automatic diagnosis and identification of COVID-19, we used three pre-trained approaches, including ResNet50, InceptionV3, and InceptionResNetV2. Patients with bacterial, viral, and four types normal pneumonia were included in the case studies. In three separate datasets, the authors demonstrated that ResNet50 provides the maximum accuracy.

For the diagnosis of COVID-19, we suggested a CNN model using AlexNet. The simulation made use of a dataset of 361 CT pictures and 170 X-ray images of COVID-19 disease that were gathered from five distinct sources. According to quantitative findings, the updated CNN model obtains 94.10% accuracy, 90% sensitivity, and 100% specificity in CT images, compared to AlexNet's 98% accuracy, 100% sensitivity, and 96% specificity in X-ray pictures.

For COVID-19 detection, we used eight deep learning (DL) models: Inceptionv3, ResNet50, Attention ResNet50, fully convolutional network (FCN-8 s), UNet, VNet, 3D UNet++, dual-path network (DPN-92). 1,136 CT scans (723 with COVID-19 and 413 normal) gathered from five hospitals were used to assess the effectiveness of the proposed models.

We applied UNet++ to detect COVID-19 in CT scan images. A dataset of 106 CT scan pictures was used to evaluate UNet++'s performance. According to simulation studies, UNet++ offers a per-patient accuracy of 95.24 percent, a sensitivity of 100 percent, and a specificity of 93.5 percent. The accuracy per image was 98.85%, the sensitivity was 94.34%, and the specificity was 99.16%. For COVID-19 detection instances, we presented five deep CNN models (VGG19, MobileNetv2, Inception, Xception, and Inception ResNetv2). The proposed models were evaluated using two datasets, each with 1428 and 1442 pictures.

Specialized CNN Approaches for COVID–19

We created the Details Relation Extraction neural Network (DRE-Net) as a deep learning model for precise detection of COVID-19-infected individuals. The effectiveness of DRE-Net was validated using 275 chest scan images (101 with bacterial pneumonia, 88 with COVID-19, and 86 with normal images). DRENet can identify COVID-19 infected patients with an average accuracy of 94%, AUC of 99%, and sensitivity of 93%, according to simulation data. For the purpose of diagnosing COVID-19 from CT scan pictures, we put out a deep learning technique named COVNet. The results of the simulation revealed that the proposed COVNet achieves an AUC, sensitivity, and specificity of 96%, 90%, and 96%, respectively. The dataset used in the simulation consisted of 4356 chest CT images from 3222 patients collected from six hospitals between August 2016 and February 2020.

For COVID-19 Diagnosis, we suggested a brand-new and effective Deep Bayes-SqueezeNet-based system (COVIDiagnosisNet). Results showed that COVIDiagnosis-Net outperformed previous network models by attaining 98.26% of accuracy, 99.13% of specificity, and 98.25% of F1-score on a dataset of 5949 chest X-ray images, including 1583 normal, 4290 pneumonia, and 76 COVID-19 infection cases. We suggested DarkCovidNet for COVID-19 automated detection. Two datasets—a COVID-19 X-ray image database created and a ChestX-ray8 database made available by us—were used to assess DarkCovidNet's effectiveness. For the purpose of identifying COVID-19 cases from chest X-ray images, we suggested the Covid-Net deep learning model. The effectiveness and superiority of the suggested Covid-Net model over the VGG-19 and ResNet-50 methodologies were demonstrated by quantitative and qualitative data.

For the automatic detection of COVID-19 instances, we suggested POCOVID-Net. To assess the performance of the POCOVID-Net model, a dataset of 1103 lung ultrasound (POCUS) images, sampled from 64 videos, was employed. This dataset included 654 COVID19 images, 277 images with bacterial pneumonia, and 172 normal images. The POCOVIDNet model performs admirably, as evidenced by its 0.89 accuracy, 0.88 precision, 0.96 sensitivity, 0.79 specificity, and 0.92 F1-score.

For the diagnostic and prognostic analysis of COVID-19 instances in CT scans, we suggested COVID-19Net. The simulation was conducted using a dataset of chest CT scans gathered from six cities or provinces, including Wuhan City in China. The findings demonstrated the COVID-19Net's strong performance, with AUC of 87%, accuracy of 78.32%, sensitivity of 80.39%, F1 score of 77%, and specificity of 76.61%. A brand-new model (CoroNet) for COVID-19 identification and diagnosis was put out by Khan et al. [164]. CoroNet was tested in three different scenarios: I Binary 2-class CoroNet (COVID-19, Normal, and Pneumonia); ii) 3-class CoroNet (COVID-19, Normal, and Pneumonia); and iii) 4-class CoroNet (normal, viral pneumonia, bacterial pneumonia, and COVID-19 pictures).

Other Deep Learning Approaches:

For the purpose of early diagnosis of covid19, we presented a stack hybrid model named Composite Hybrid Feature Selection Model (CHFS) based on the fusion of CNN and machine learning methods. Using a dataset of 51 CT scans split into training and testing sets, the effectiveness of CHFS was assessed. Achieving an F1-score, precision, sensitivity, and accuracy of 96.10%, 96.10%, 96.10%, and 96.07%, respectively, were according to simulation data. A Deep Learning-Based Computer-Aided Detection (CAD) System was used to identify patients who were infected with COVID-19. The chest X-ray and CT pictures used to train the CAD system revealed that it achieves 68.80% sensitivity and 66.70% specificity with the chest X-ray images and 81.5% sensitivity and 72.3% specificity with the CT images.

For the detection and categorization of COVID-19 from CT scans, we suggested a multi-task deep learning approach. The performance of the suggested method was assessed using a dataset of photographs gathered from 1369 patients. Results showed that the suggested method has an AUC of 0.97, a sensitivity of 0.96, a specificity of 0.92, and an accuracy of 94.67.

We suggested a fast-track COVID-19 classification network (FCONet) that leverages one of the pre-trained deep learning models as the foundation for diagnosing COVID-19 pneumonia (VGG16, ResNet50, Inceptionv3, or Xception). By reaching a sensitivity of 99.58%, specificity of 100%, accuracy of 99.87%, and AUC of 100%, experimental results showed that FCONet with ResNet50 delivers good diagnostic performance.

On the basis of CT scan images, we suggested a stacked auto-encoder detector model for the diagnosis of COVID-19 Cases. The findings show that the suggested model performs well, with average accuracy, precision, sensitivity, and F1 score of 94.70%, 96.54%, and 94.80%, respectively. In order to automatically diagnose COVID-19 cases from digital X-ray pictures, we proposed a novel model (CAD-based YOLO Predictor) based on rapid deep learning computer-aided diagnosis system with YOLO predictor. Two separate digital X-ray datasets, COVID-19 images and ChestX-ray8 images, were used to train the proposed system. The experiment shows that the CAD-based YOLO Predictor has an F1 score of 84.81%, an accuracy of 97.40%, a sensitivity of 85.15%, a specificity of 99.06%, and a specificity of 99.06%.

RESULTS:

The area of AI known as machine learning has been used to address COVID-19. The study's conclusions show that:

- A variety of machine learning techniques are applied in this setting. Only 5% of the examined publications used other types of learning, whereas 79% of them were based on Deep Learning, 16% on Supervised Learning, and none used techniques often used in the field of Unsupervised Learning.
- Similar to how techniques of Reinforcement Learning are not addressed in the summary ways; deep learning makes automatic learning, which is a type of unsupervised learning, in the case of unlabeled data.

  The Deep Learning method that is most frequently employed is CNN.
- This architecture was used to manage the collected data by 65% of DL-based methods. A novel CNN architecture specifically designed for COVID-19 data types was created by 17% of them. The capacity provided by CNN to train many layers with nonlinear mappings to categorise highly dimensional input data into a collection of classes at the output layer is the primary motivator. CNN was therefore found to be the best option given the vast volume of medical data.
- Regression was chosen by 70% of the approaches based on supervised learning. Either Linear Regression or Random Forest Algorithms are used to perform regression. For its part, SVM approach is used for classification in 30% of articles based on supervised learning. We have observed the extensive usage of metrics in the assessments of the suggested strategies. In fact, accuracy appears to have a little advantage even when the results of other measures are equal. Since it is one of the most significant metrics in ML and can be applied to both classification and prediction, this is unimportant. Even with all of these improvements, applying ML to the COVID-19 still presents some difficulties.
- In reality, processing fresh datasets created in real-time has a number of challenges that are restricting the effectiveness of the outcomes. In actuality, a large number of the suggested methods are based on limited datasets. They frequently have a high ratio of missing patterns, are noisy, confusing, and incomplete.

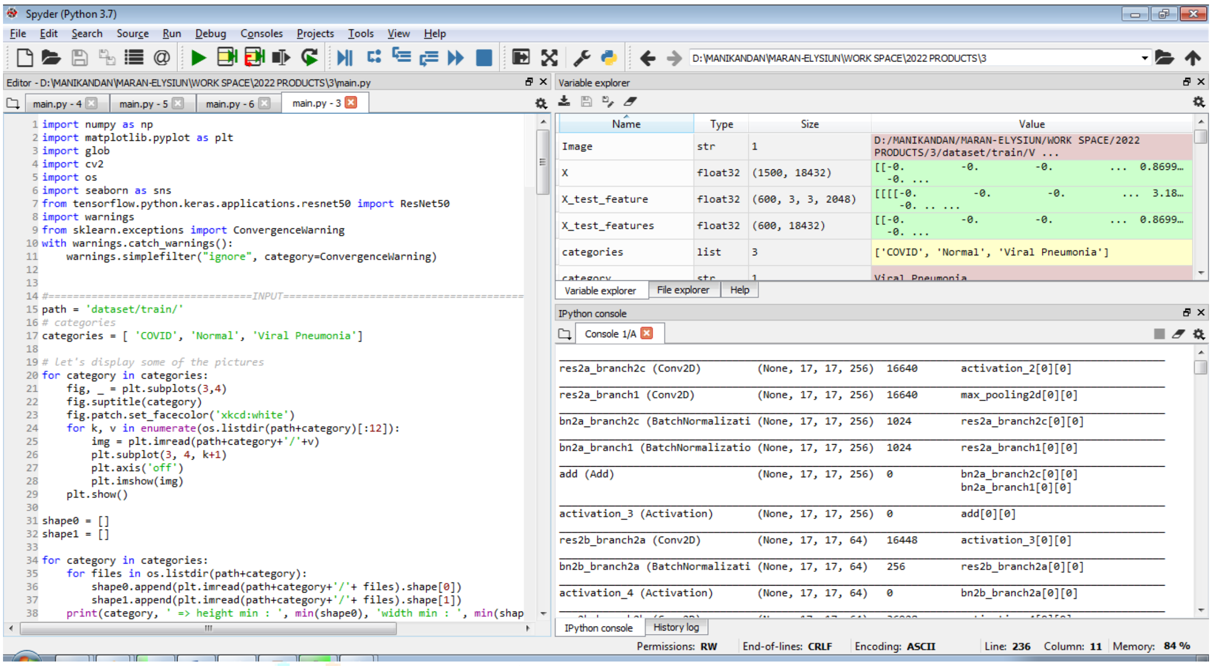

Fig.1. Output Screen 1

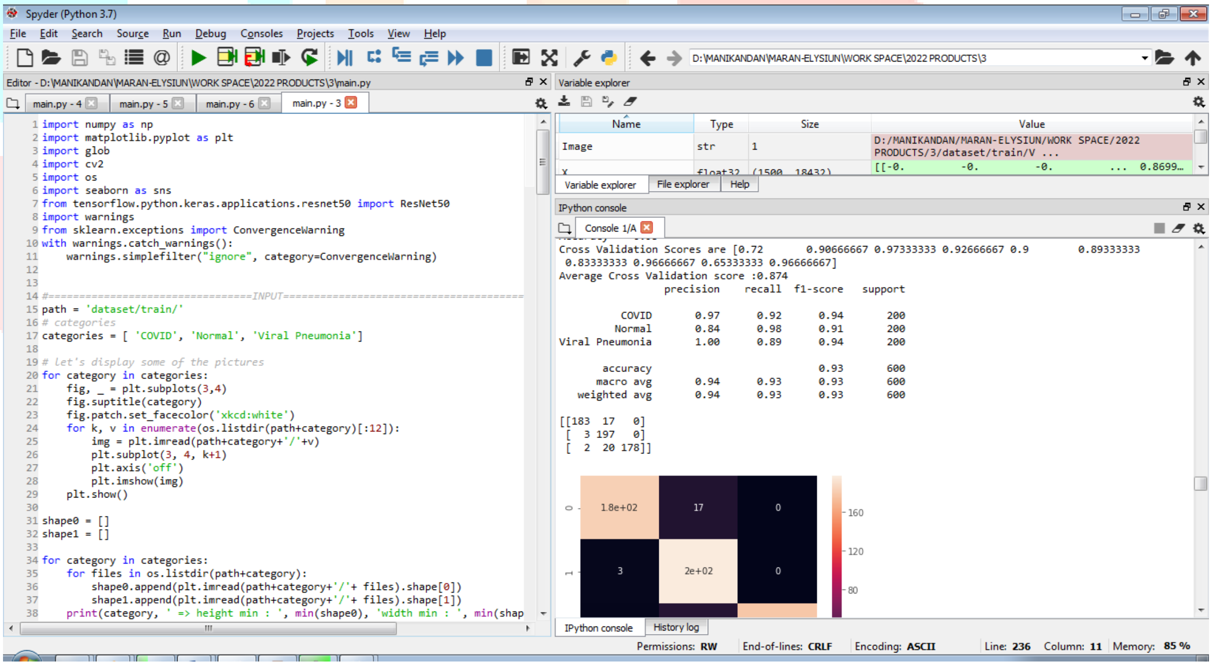

Fig.2. Output Screen 2

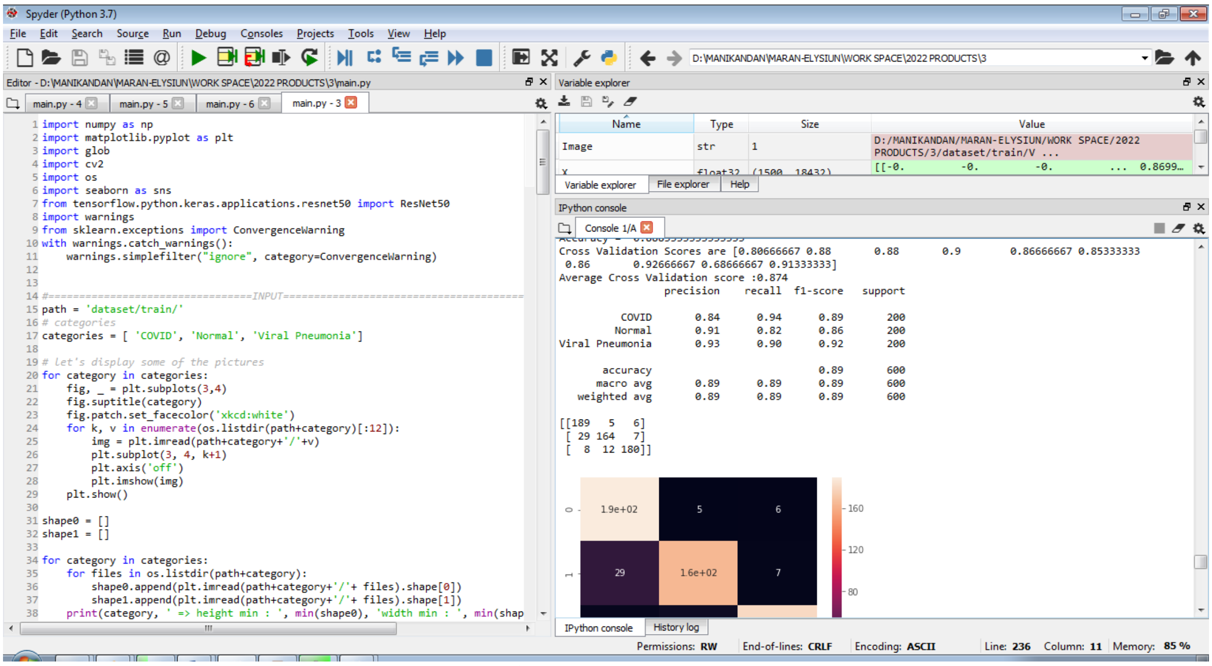

Fig.3. Output Screen 3

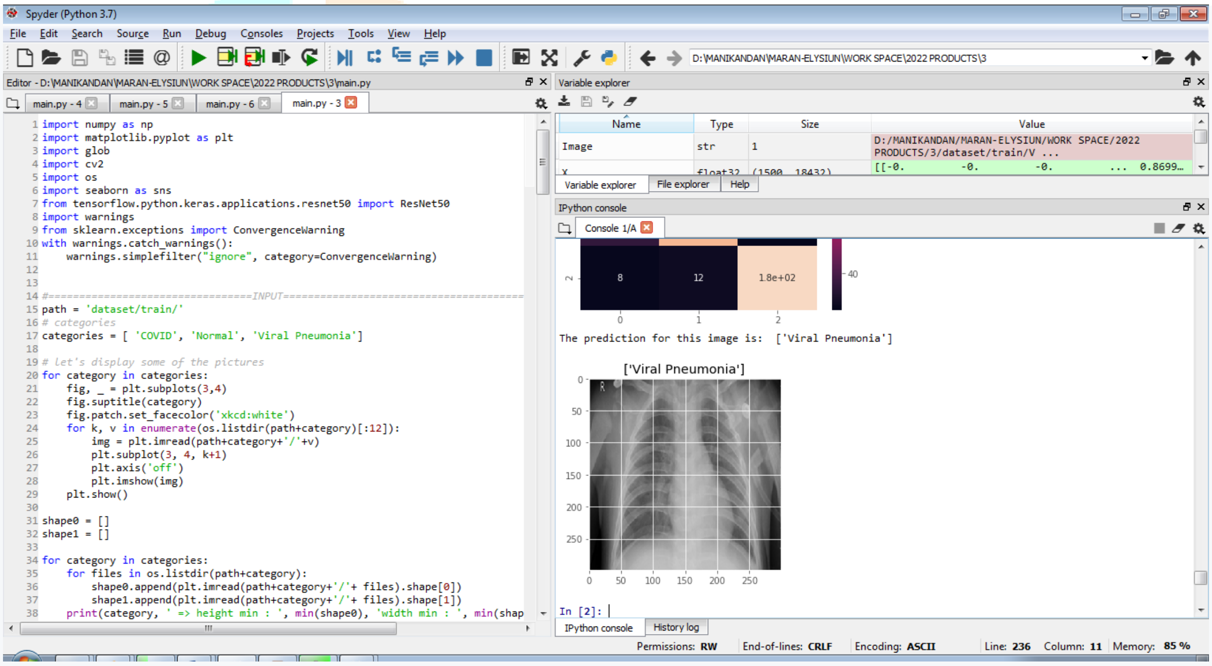

Fig.4. Output Screen 4

III. CONCLUSION

The COVID-19 pandemic has left a lasting impression on 2020 and has prompted responses from the scholarly community across a variety of sectors. This paper illustrated the fascination data scientists have for this specific circumstance. In order to achieve COVID-19 detection, diagnosis, or prediction, it presented a survey of machine learning-based research that is divided into two areas (supervised learning approaches and deep learning approaches). Additionally, it provided statistics and an analysis of published publications. More than 160 papers from more than six renowned scientific publishers were included in the review. The learning is based on a variety of data sources, including blood samples, X-ray pictures, CT images, text data, time series, sounds, and videos of people coughing and breathing.

The two techniques that are most widely used are algorithms and linear regression. Hybrid techniques are also investigated to handle the COVID-19 issue in addition to these. They make up 5% of the methods this article reviewed. Given the current state of the art and the variety of methodologies being presented, research must now concentrate on the standard and harmonization of the data used. Indeed, up until this point, researches have been conducted using a variety of dataset kinds and sizes. The statistics taken into account are those that are generally available in every nation, even though the COVID-19 disease has not always developed in the same way. Therefore, it is crucial to develop benchmarks using real-world datasets so that future models can be trained on them.

ACKNOWLEDGMENT

I pay thanks to our project guide Prof. Priti Vijaykumar Pancholi for assistance and guidance especially related to technicalities and also who encouraged and motivated us.

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