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Machine Learning and Deep Learning to Do Early Predictions of COVID-19 Infection Using Chest X-Ray Images

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ABSTRACT— In this paper, we seek to present or explain how an application that helps in the process of diagnosing the Corona virus (COVID-19) was designed through the use of X-rays of the respiratory system of the person to be examined where this application was built based on artificial intelligence techniques that are represented in the algorithms of learning machine and deep learning, and with the expectation of a rapid increase in the spread of infection and the emergence of new cases, due to the scarcity of health resources, which require a long time in conducting tests in the laboratories for diagnosing the virus, according to which these results diagnose the patient, as no quarantine is imposed on the person who is the furthest to obtain the result, and it is this period that is waiting The results will spread the virus more quickly due to crowding. We have focused on this situation where the application displays the results very quickly too. The application can move in more than one health center, even in poor areas. Where the main idea is to take an X-ray for a person, enter the image for application, and give immediate results in less than a second, which helps in speeding the diagnosis and reducing congestion.

KEYWORDS: Machine Learning, Deep Learning, Python GUI- Tkinter, COVID-19, X-Ray.

1. INTRODUCTION

Since the start of 2020, Coronavirus Disease 2019 (COVID-19) has vastly spread everywhere the planet. It is very infectious and may cause acute dyspnoeal or various organ insufficiency in critical cases. World Health Organization (WHO) reported that coronaviruses belong to a big family group from the common cold to dangerous illnesses, and on January 30, 2020 the outbreak was announced as a "public health emergency of international concern" (PHEIC) by (WHO). Currently it is not easy to have COVID-19 test due to unavailability of diagnosis system everywhere, and finite availability of testing kits. Therefore, it is very necessary to find other diagnosis measures. Since COVID-19 attacks the respiratory tract, so it is effective to use X- rays to analysis the health of a patient's lungs. Again, the problem is that analysis X-ray need experts and takes long time. Which is precious when patients are suffering around the world. Therefore, developing an automated analysis system is indispensable to save medical experts time and achieve better results [1]. Recently, deep learning-based AI has achieved great success and shown its abilities across multiple medical domains. It shines particularly in well-defined clinical tasks where most of the information necessary for the task is contained in the data [2]. We have sought to design and build an application built in the Python language that relies on artificial intelligence techniques such as deep learning and machine learning. Where the application predicts the condition of a person who is infected with the Corona virus or not infected, by entering X-rays of a person to be examined in order to make sure whether he is infected or not infected [3]. Since the virus is dangerous, it lies in its rapid spread, as mixing is a contributing factor in its spread and also expensive

tests. It requires a great time. The application solved all these problems as it is possible to navigate the application and place copies of it in more than one health center, which helps to avoid contact with infected people and the virus also does not spread, and the speed in producing results and less costly. The application will solve a lot of the problem as it helps in early diagnosis, by classifying the injured and the uninfected, which removes ambiguity [4, 5, 6].

2. Related work

Many deep learning classifiers for diabetic retinopathy have been published in the last years. In [11] a DL classifier was published for the prediction of the different disease grades. This model was trained using the public available EyePACS dataset. The training set had 35,126 images and the test set 53,576. The quadratic weighted kappa (QWK) evaluation metric [12] was close to the reported by human experts in the test set using a unique DL model without ensembling. In [10] a binary DL classifier was published for the detection of the most severe cases of DR (grouping classes 0 and 1 of DR on one side, and classes 2, 3 and 4 on another). This model was trained using an extended version of the EyePACS dataset mentioned before with a total of 128,175 images and improving the proper tagging of the images using a set of 3 to 7 experts chosen from a panel of 54 US expert ophthalmologists. This model surpassed the human expert capabilities, reaching approximately a performance of 97% in sensitivity and 93.5% in specificity in test sets of about 10,000 images. The strength of this model was its ability to predict the more severe cases with a sensitivity and specificity greater than human experts. The drawback, as many DL based models, is its lack of interpretability. The model acts like a intuition machine with a highly statistical confidence but lacking an interpretation of the rationale behind the decisions, making difficult to the experts to have clues to improve the diagnostics. In last years, different approximations have been proposed to convert the initial DL black box classifiers into interpretable classifiers. In the next sections we introduce the most successful interpretation models existing today: sensitivity maps, layer-wise relevance propagation and Taylor decomposition models. Motivated by the above work, in this paper, we seek to present or explain how an application that helps in the process of diagnosing the Corona virus (COVID-19) was designed through the use of X-rays of the respiratory system of the person to be examined where this application was built based on artificial intelligence techniques that are represented in the algorithms of learning machine and deep learning, and with the expectation of a rapid increase in the spread of infection and the emergence of new cases, due to the scarcity of health resources, which require a long time in conducting tests in the laboratories for diagnosing the virus, according to which these results diagnose the patient, as no quarantine is imposed on the person who is the furthest to obtain the result, and it is this period that is waiting the results will spread the virus more quickly due to crowding.

3. Methodology

Since the methodology is a major part of the research parts that contain the means or tools used to complete the search, we have worked to list you all the tools used in the search application and to you explain these tools in detail step by step:

3.1 TOOLS

i. Python may be a strongly structured, object-oriented and dynamic semantic programming language. it's very marketable for fast development also as for the utilization of existing components as scripting or glue language with a better level of knowledge structure, in combined effect with dynamic and dynamic binding. The straightforward, quick-to-learn syntax of Python emphasizes readability and further reduces program cost of maintenance. Whereas, Pathon supports the work on all artificial intelligence algorithms, especially in the field of machine learning and deep learning, which is the core of our work as it provided many offices that provide information analysis and also classification of data, which was characterized by its small code and high and accurate performance.

ii. PyCharm is an integrated development environment (IDE) utilized in programming, specifically for the Python language [7]. It's developed by the Czech company JetBrains. [8] It provides code analysis, a graphical debugger, an integrated unit tester, integration with version control systems (VCSes), and supports web development with Django as Data Science with Anaconda. [9] PyCharm is cross-platform, with Windows, macOS and Linux versions.

iii. Keras Library Simple to utilize and generally upheld, Keras makes profound finding out about as basic as deep learning can be. While deep neural networks are extremely popular, the intricacy of the significant structures has been a hindrance to their utilization for designers new to machine learning. There have been a few recommendations for improved and streamlined elevated level APIs for building neural network models, all of which will in general appear to be comparative from a separation however show contrasts on nearer assessment. Keras is one of the main elevated level neural systems APIs. It is written in Python and supports various back-end neural system calculation motors.

iv. Python GUI-Tkinter Python offers various choices for creating GUI (Graphical UI). Out of all the GUI techniques, tkinter is the most normally utilized strategy. It is a standard Python interface to the Tk GUI toolbox dispatched with Python. Python with tkinter is the quickest and least demanding approach to make the GUI applications. Making a GUI utilizing tkinter is a simple assignment.

v. X-Rays are a type of electromagnetic radiation, like obvious light. In contrast to light, nonetheless, x-rays have higher vitality and can go through most items, including the body. Clinical x-rays are utilized to produce pictures of tissues and structures inside the body. On the off chance that x-rays going through the body likewise go through a x-rays locator on the opposite side of the patient, a picture will be shaped that speaks to the "shadows" framed by the articles inside the body.

vi. Dataset introduction A collection of 600 X-ray lungs images of the lungs obtained from the site gethub and kagel were divided into 400 pictures of people with COVID-19 and 200 of non-infected people. As the focus was on taking samples of the patient, observing and taking more than one diagnostic image in order to check the diagnosis, studies have proven that the X-ray images are the first tool to diagnose the disease.

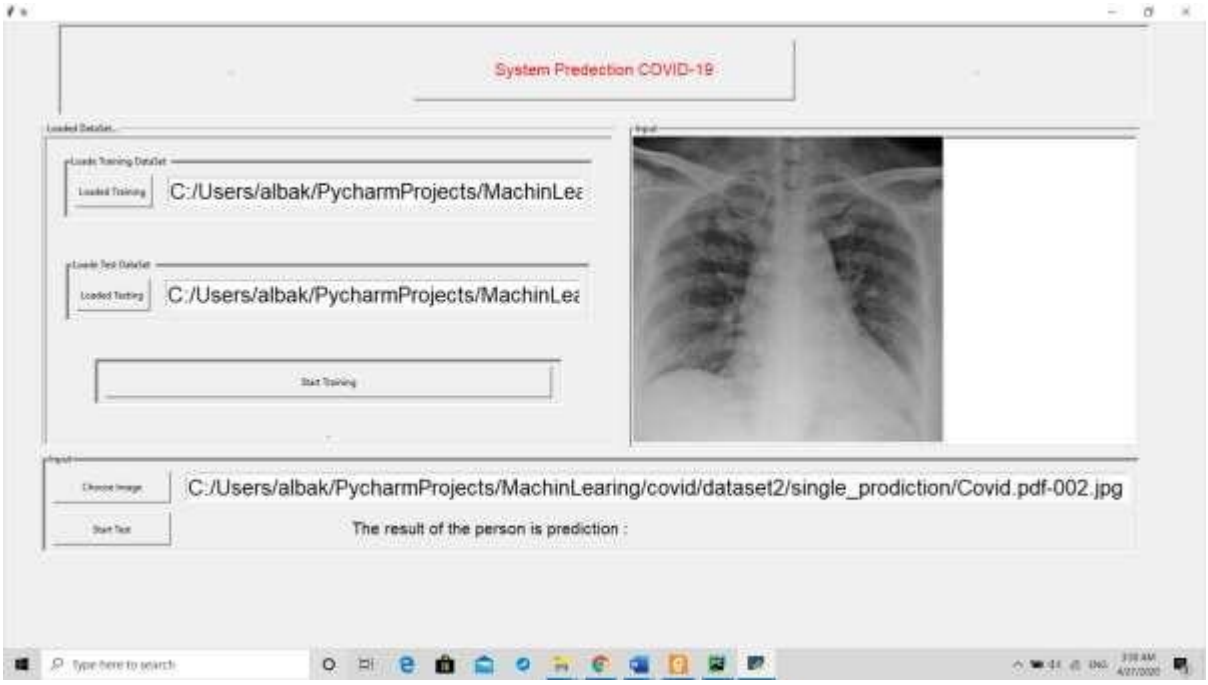
vii. Deep learning a class of AI calculations that utilizes different layers to continuously extricate more significant level highlights from the crude info. For instance, in picture handling, lower layers may recognize edges, while higher layers may distinguish the ideas pertinent to a human, for example, digits or letters or faces.

viii. Convolutional Neural Network (CNN) Convolutional neural network (CNN) is a class of deep neural systems that works in investigating pictures and in this manner is generally utilized in PC vision applications, for example, picture order and grouping, object identification, and neural style move. To comprehend CNN, allows first gander at what convolution is. Let's assume we have a 5×5 grayscale picture and a 3×3 framework called channel or portion, and we need to "convolve" the picture by performing component astute network increase for each 3×3 square of the picture with the channel and afterward taking the entirety of the items. The wholes will turn into the components of the subsequent 3×3 picture. In the model beneath, we compute the primary component of the new picture, and the rest can be determined utilizing a similar methodology.

4. Design

The application has been designed using the Python language, which supports an interactive user interface that helps to complete the scan very accurately and quickly.

Where he helped to avoid injury operations, which is produced through mixing, but when using this application solves this problem by making multiple copies in more than one place, which reduces the process of crowding.



5. Implementation

When the implementation process, we will show you the main operations of the application:

5.1 Loading Dataset Training:

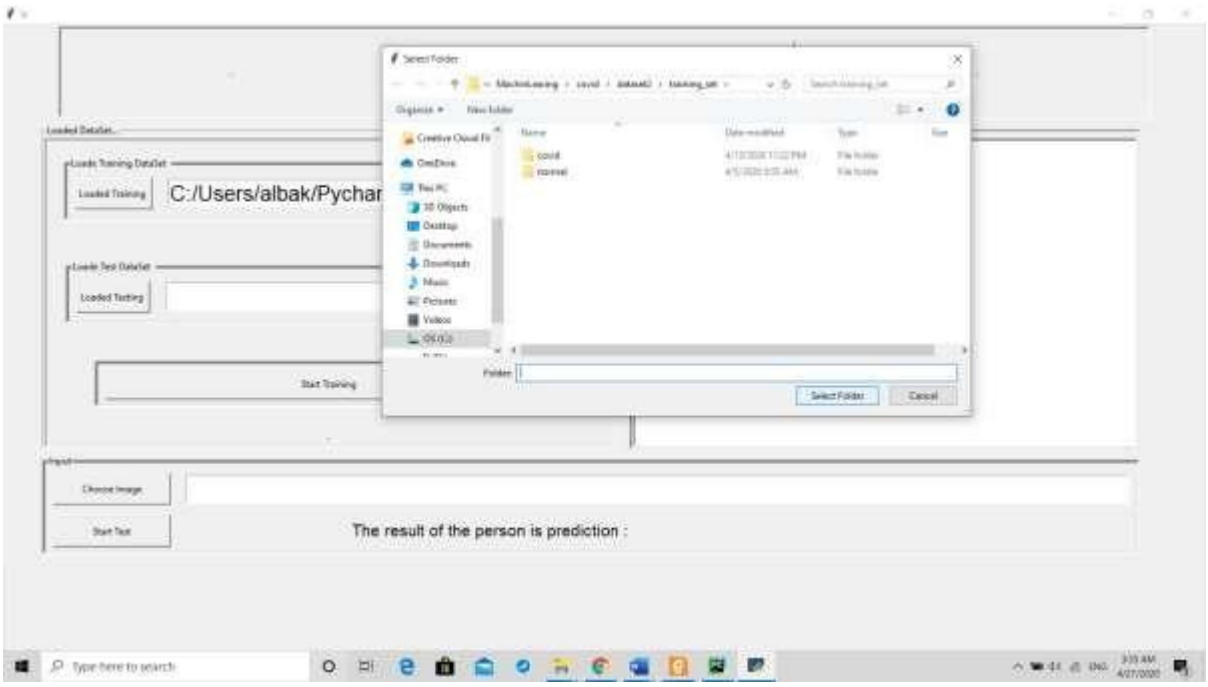


Figure 1. loading dataset training from folder “training_set” divided two folders “covid” and “normal”

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5.2 Loading Dataset Testing

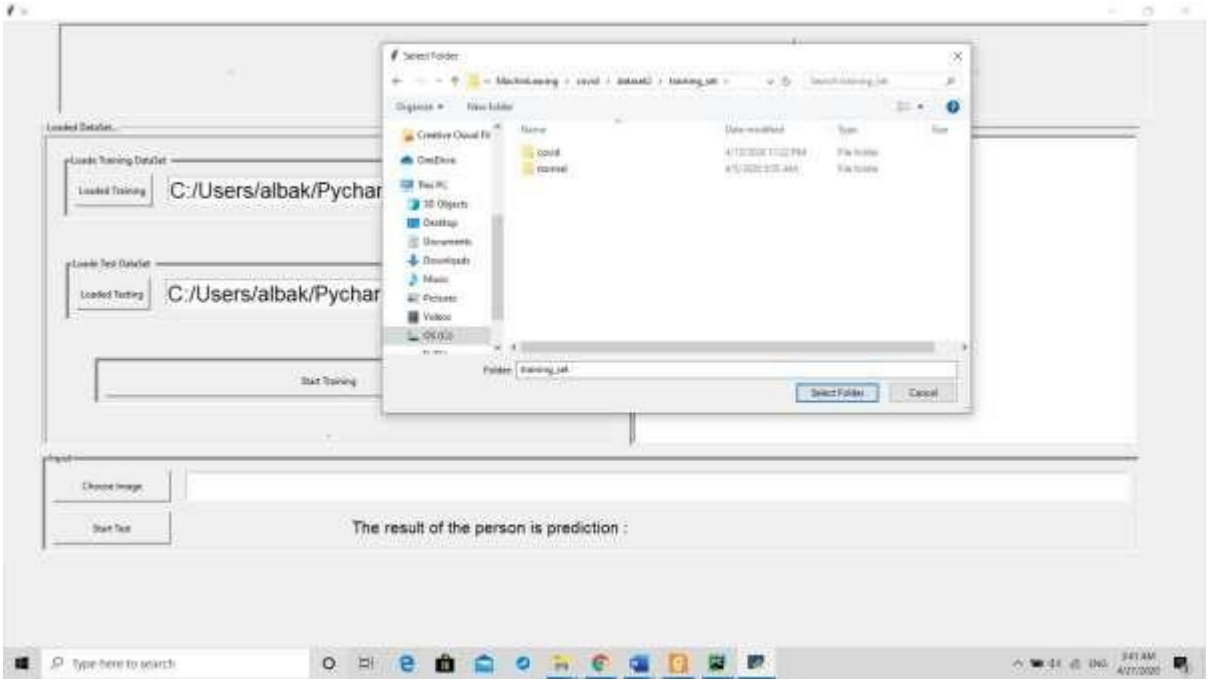

Figure 2. Loading dataset training from folder "testing set" divided two folders "covid" and "normal"

5.3 Loading the Image Input:

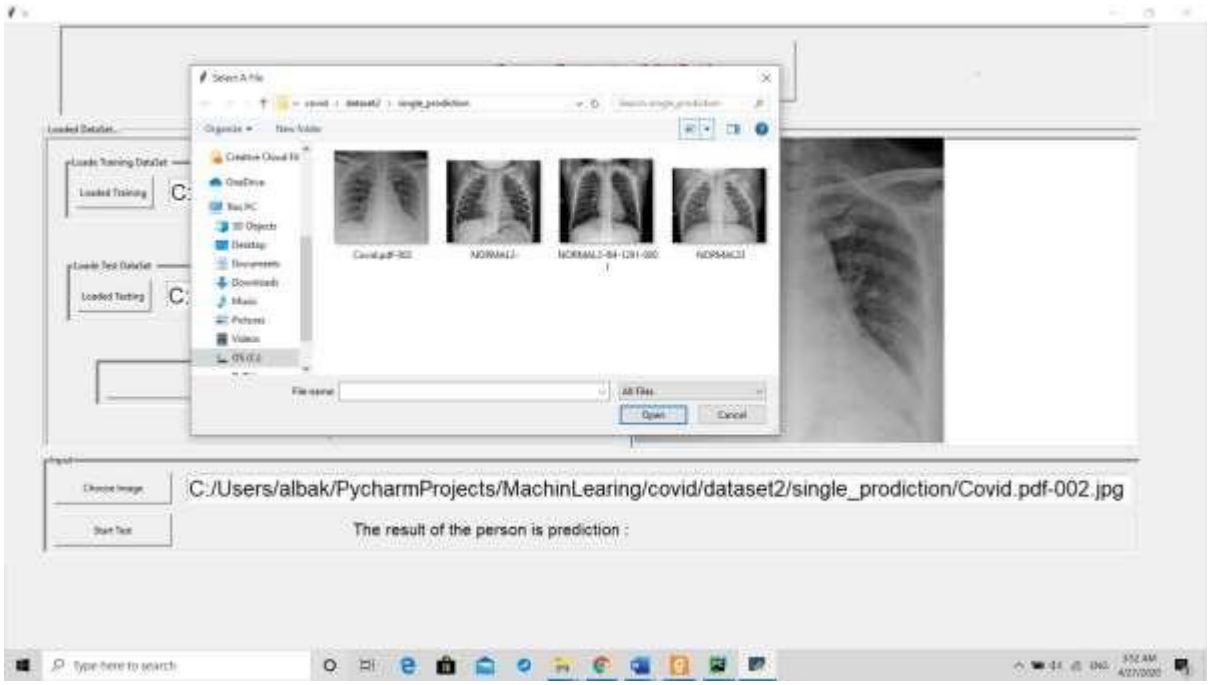

Figure 3. Loading the photo of the person, you want to check from folder "single_prediction"

6. Result and Analysis

Pneumonia is lung aggravation brought about by disease with infection, microscopic organisms, growths or different pathogens. As indicated by National Institutes of Health (NIH), chest x-ray is the best test for pneumonia conclusion. Be that as it may, perusing COVID-19 is one of the viruses that target the respiratory system x-ray pictures can be dubious and requires space mastery and experience. It would be pleasant on the

off chance that we can simply request that a PC read the pictures and disclose to us the outcomes. In this story, we will utilize profound figuring out how to prepare a computer based intelligence calculation that breaks down chest x-ray pictures and recognizes pneumonia.

6.1 Process

In fact, deep learning CNN models to train and test, each information picture will go it through a progression of convolution layers with filters (Kernals), Pooling, fully connected layers (FC) and apply prediction capacity to characterize an item with probabilistic qualities somewhere in the range of 0 and 1. The beneath figure is a finished progression of CNN to process an info picture and arranges the items dependent on values.

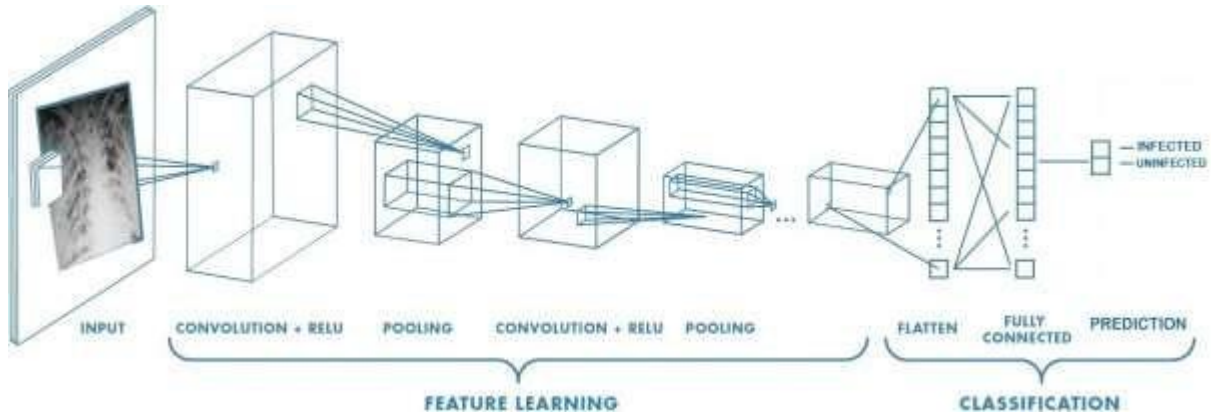

Figure 5: Neural network with many convolutional layers

6.2 Convolution Layer

Convolution is the main layer to extricate highlights from an input picture. Convolution protects the connection between pixels by learning picture highlights utilizing little squares of information. It is a scientific activity that takes two information sources, for example, picture array and a filter or bit.

1. An image matrix (volume) of dimension (h * w * d).
2. A filter (f_h * f_w * d)
3. Outputs a volume dimension (h – f_h +1) *(w – f_w +1) *1.

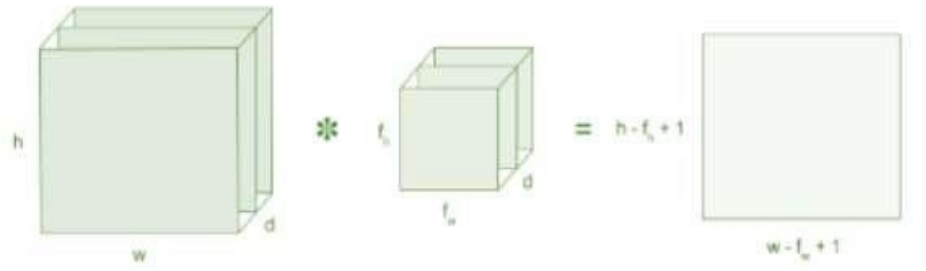

Figure 6: Image matrix multiplies kernel or filter matrix

Consider a 5 x 5 whose image pixel values are 0, 1 and filter array 3 x 3 as shown in below

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Figure 7: Image matrix multiplies kernel or filter matrix

At that point the convolution of 5 x 5 picture lattice increases with 3 x 3 array grid which is designated "Feature Map" as yield appeared in beneath

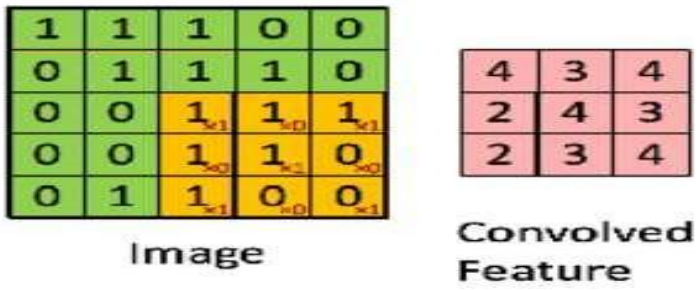

Figure 8: 3 x 3 Output matrix

6.3 Strides

Strides is the quantity of pixels moves over the input matrix. At the point when the step is 1 then we move the filters to 1 pixel at once. At the point when the step is 2 then we move the filters to 2 pixels one after another, etc. The underneath figure shows convolution would work with a step of 2.

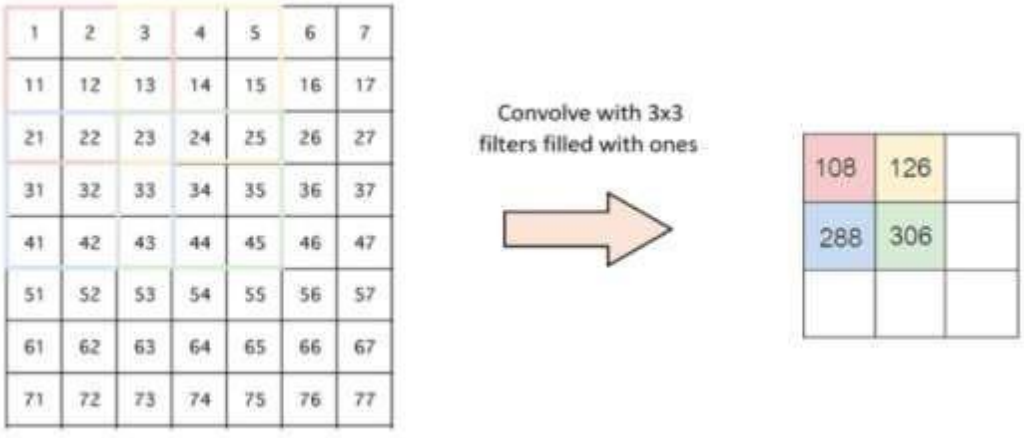

Figure 9: Stride of 2 pixels

6.4 Padding

Once in a while filter doesn't fit impeccably fit the input picture. We have two alternatives:

- Pad the image with zeros (zero-padding) so it fits.

• Drop the piece of the picture where the filter didn't fit. This is called legitimate padding which keeps just substantial piece of the picture.

Non Linearity (ReLU):

ReLU represents Redressed Straight Unit for a non-linear activity. The yield is $f(x) = \max(0, x)$.

Why ReLU is significant: ReLU's motivation is to present non-linearity in our ConvNet. Since, this present reality information would need our ConvNet to learn would be non-negative straight qualities.

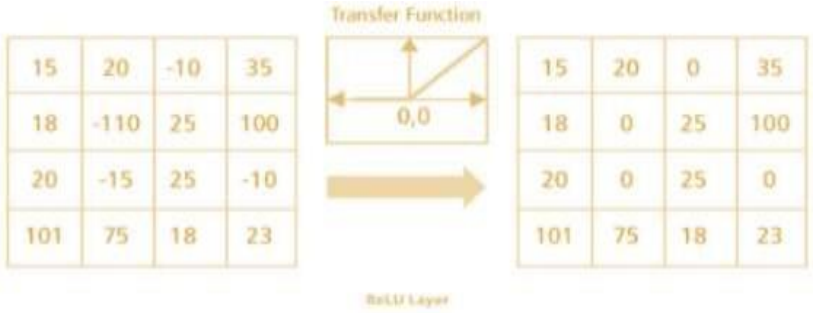

Figure 10: ReLU operation

There are other nonlinear functions, for example, tanh or sigmoid that can likewise be utilized rather than ReLU. The majority of the information researchers use ReLU since execution insightful ReLU is superior to the next two.

6.5 Pooling Layer

Pooling layers' segment would lessen the quantity of parameters when the pictures are excessively enormous. Spatial pooling likewise called subsampling or downsampling which lessens the dimensionality of each guide however holds significant data. Spatial pooling can be of various sorts:

1. Max Pooling.
2. Average Pooling.
3. Sum Pooling.

Max pooling takes the biggest component from the corrected element map. Taking the biggest component could likewise take the normal pooling. Entirety of all components in the element map call as aggregate pooling.

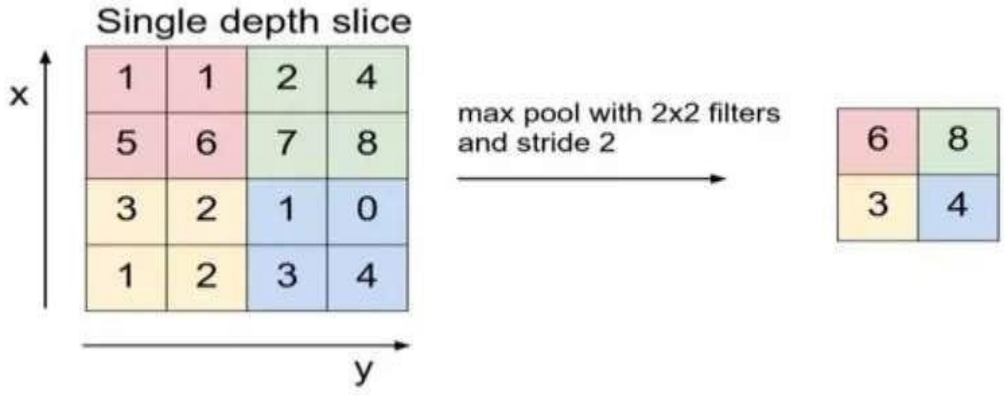

Figure 11: Max Pooling

6.6 Fully Connected Layer

The layer we call as FC layer, we flattened our array into vector and feed it into a fully connected layer .

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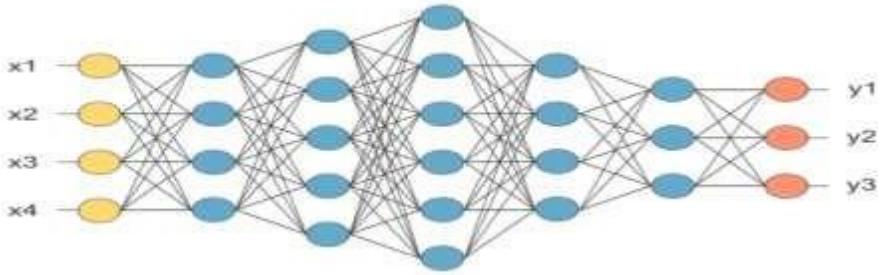

Figure 12: After pooling layer, flattened as FC layer

In the above chart, the element map grid will be changed over as vector (x1, x2, x3, …). With the completely associated layers, we joined these highlights together to make a model. At long last, we have an activation function, for example, Perdictive or sigmoid to arrange the result as infected or Uninfected.

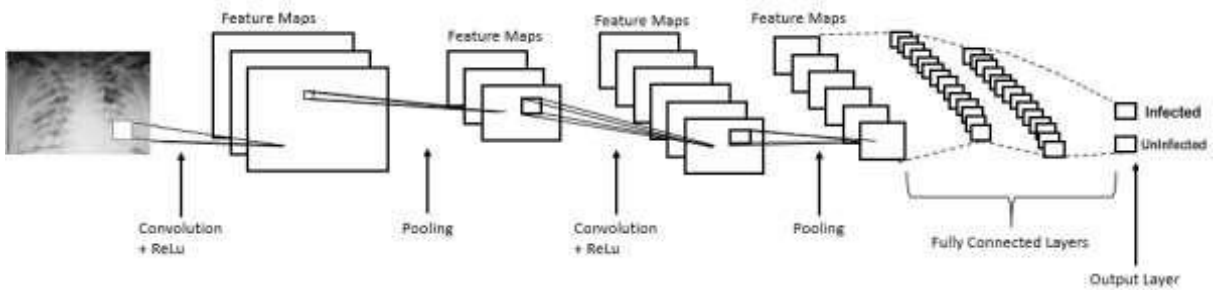

Figure 13: Complete CNN architecture

7. Discussion

COVID-19, which was first distinguished in Wuhan China, has caused genuine open wellbeing security issues and subsequently become a worldwide concern [1, 14]. The extreme circumstance advances new prerequisites for the anticipation and control technique. A huge number of patients with viral pneumonia had been distinguished in Wuhan city. The RT-PCR trial of 2019-nCoV RNA can make an unmistakable analysis of COVID-19 from Flu a viral pneumonia patient. Be that as it may, the nucleic corrosive testing has a few surrenders, for example, time slack, moderately low identification rate, and shy of supply. In the beginning period of COVID-19, a few patients may as of now have positive pneumonic imaging discoveries yet they have no sputum and negative test brings about nasopharyngeal Along these lines, they are not being disconnected or treated just because, making them potential wellsprings of disease. The X-ray imaging of COVID-19 present a few unmistakable appearances concurring to past studies [11, 12] The signs incorporate focal ground glass shadows primarily dispersed in two-sided lungs, numerous solidification shadows joined by the "corona sign" of encompassing ground glass shadow in the two lungs, work shadows and bronchiectasis and blowing up signs inside the sores, and different solidification of various sizes and framework molded high-thickness shadows. Be that as it may, it isn't objective and exact to recognize COVID-19 from different maladies just with natural eyes. In examination, profound learning framework based screen models uncovered increasingly explicit and dependable outcomes by digitizing and normalizing the picture data. Thus, they can help doctors to settle on a fast clinical choice all the more precisely, which would advantage on the executives of suspected patients. swabs of RT-PCR. These patients are not analyzed as suspected or affirmed cases. In this study, the deep learning technology was used to design a classification network for distinguishing the COVID-19 from Influenza-A viral pneumonia. In terms of the network structure, the classical ResNet was used for feature extraction. It was compared with the network model with and without the added location-attention mechanism. The experiment showed that the aforementioned mechanism could better distinguish

COVID-19 cases from others. The manifestation of COVID-19 may have some overlap with the manifestations of other pneumonias such as Influenza-A viral pneumonia, organic pneumonia and eosinophilic pneumonia. The clinical diagnosis of COVID-19 needs to combine the patients' contact history, travel history, first symptoms and laboratory examination. In this study, the number of model samples was limited. Hence, the training and test the number of samples should be expanding to improve the accuracy in the future. More multi-center clinical studies should be conducted to cope with the complex clinical situation. We have worked to facilitate work by building an application using the Python language that has a user interface that helps in the work and accomplish the prediction process as quickly as possible and with very high accuracy.

8. Conclusion

After we have completed the explanation process and what tools are used in the previous sections. We have been keen to build an application that works to prove the effectiveness of artificial intelligence techniques, especially machine learning and deep learning. The summary of this work is to create an application that helps health systems in the process of discovering cases that are coronavirus (COVID-19) by taking X-rays and inserting them into the application, which is the work environment is by convolutional neural networks (CNN) where this application will solve the problem of delay in diagnosing cases, which laboratories take in checks, also solves the problem of congestion, where several copies can be made to apply in separate places in order to conduct the examination and issue it in less than a second, as well as the low cost in conducting the examination and reducing the cost to the citizen. The application does not need an expensive infrastructure, it only needs a personal computer in order to install the program on it and start working inconsistently. Where in the future he will be added and developed by adding systems to assist in the diagnostic process, such as a blood test (CBC), which will become supportive systems for the client of diagnosis and prediction.

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