WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Detecting the Covid-19 From X-Rays by Using Deep Learning

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A B S T R A C T

Most detection methods of corona virus disease 2019 (COVID-19) use classic image classification models, which have problems of low recognition accuracy and inaccurate capture of modal features when detecting chest X-rays of COVID-19. This study proposes a COVID-19 detection method based on image modal feature fusion. This method first performs small-sample enhancement processing on chest X-rays, such as rotation, translation, and random transformation. Five classic pretraining models are used when extracting modal features. A global average pooling layer reduces training parameters and prevents overfitting. The model is trained and fine-tuned, the machine learning evaluation standard is used to evaluate the model, and the receiver operating characteristic curve is drawn. Experiments show that compared with the classic model, the classification method in this study can more effectively detect COVID-19 image modal information, and it achieves the expected effect of accurately detecting cases using CNN Algorithm.

Keywords: COVID-19, Deep Learning, Convolutional neural network (CNN),

1. Introduction

Deep learning is based on the branch of machine learning, which is a subset of artificial intelligence. Since neural networks imitate the human brain and so deep learning will do. In deep learning, nothing is programmed explicitly. Basically, it is a machine learning class that makes use of numerous nonlinear processing units so as to perform feature extraction as well as transformation. The output from each preceding layer is taken as input by each one of the successive layers. Deep learning models are capable enough to focus on the accurate features themselves by requiring a little guidance from the programmer and are very helpful in solving out the problem of dimensionality. Deep learning algorithms are used, especially when we have a huge no of inputs and outputs. Since deep learning has been evolved by the machine learning, which itself is a subset of artificial intelligence and as the idea behind the artificial intelligence is to mimic the human behavior, so same is "the idea of deep learning to build such algorithm that can mimic the brain". Deep learning is implemented with the help of Neural Networks, and the idea behind the motivation of Neural Network is the biological neurons, which is nothing but a brain cell. Deep learning is a collection of statistical techniques of machine learning for learning feature hierarchies that are actually based on artificial neural networks. So basically, deep learning is implemented by the help of deep networks, which are nothing but neural networks with multiple hidden layers. Deep learning is implemented with the help of Neural Networks, and the idea behind the motivation of Neural Network is the biological neurons, which is nothing but a brain cell. Deep learning is a collection of statistical techniques of machine learning for learning feature hierarchies that are actually based on artificial neural networks. So basically, deep learning is implemented by the help of deep networks, which are nothing but neural networks with multiple hidden layers.

1.1. CONVOLUTION

A convolution is a mathematical calculation on two functions named f and g that gives a third function (f * g). This third function reveals how the shape of one is modified by the other. Convolution is very important .It can manipulate Blurred, Sharped, Edge detection, Noise reduction images. 3 A mask (g) - a small matrix whose values are called weight. A twodimensional matrix represents it. It is also known as filtering. It's interesting point is that it should be in odd numbers. Otherwise, it is difficult to find the mid of the mask. Image (f)- preprocessed images.

- It is a mathematical calculation-based approach.

- It can manipulate Blurred, Sharped, Edge detection, Nose reduction images.

1.2. Need of fast COVID -19 detection

The COVID-19 disease has become a raging cause of its worldwide mortality rate, the current death toll reaches up to 244K. The novel corona-virus after entering through the human's respiratory tract, affects the lungs of the person critically, causing conditions like and severe than the known 'Pneumonia'. The lungs become filled with fluid, get inflamed and develop patches called Ground-Glass Opacity (GGO). Given that the symptoms of the disease are hard to recognize and there are limited testing kits available, we surely need to find other measures of its diagnosis. Since a lot of efforts are being made for finding the effective medication of COVID-19 but till today the only effective way for protection is social distancing and lockdown of various cities in the country. However, the dark side of the lockdown is that it affects the GDP of the country and also have an adverse psychological effect on the health and mind of people. The number of afflicted sufferers because of COVID-19, are increasing exponentially around the globe. The majorly affected countries like the USA, Italy, and Spain have already surpassed China and will have an adverse catastrophic impact on the global economy. Richard Baldwin, a Professor of International Economics at the Graduate Institute in Geneva said "This virus is as economically contagious as it is medically contagious,"Therefore, it is mandatory to establish a health clinic system based on Artificial Intelligence (AI) that can be able to detect the cases fast and accurately to prevent this natural pandemic.

1.3. CONVOLUTIONAL NEURAL NETWORKMODEL

CNNs are neurobiological-driven by the findings of locally sensitive and orientation-selective nerve cells in the visual cortex. They are astonishingly powerful because they can easily recognize patterns that have extreme variability. e.g., hand-writing. CNN is designed to automatically and adaptively learn spatial hierarchies of features through back propagation by using multiple building blocks, such as convolution layers, pooling layers, and fully connected layers.

Different forms of existing deep learning techniques including convolutional neural network (CNN), vanilla neural network, visual geometry group based neural network (VGG), and capsule network are applied for lung disease prediction. The basic CNN has poor performance for rotated, tilted, or other abnormal image orientation. So that Inception V3 is used as a pre trained model and for feature extraction. As implementation tools Python, TensorFlow, and Kera's are used. CNN is applied to NIH chest X-ray image dataset collected from Kaggle repository which contains 5605 images.

In comparison to VGGNet, Inception Networks (Google Net/Inception v1) have proved to be more computationally efficient, both in terms of the number of parameters generated by the network and the economic cost incurred (memory and other resources).

When CNN classification, it is usually necessary to consider the locality of the input sample, translation in variance, reduction invariance, rotation in variance, etc., to improve the accuracy of classification. The essence of these in variances is the classic methods of image processing, that is, image cropping, translation, scaling, and rotation. These methods are actually the spatial coordinate transformation of the image

1.4. BACKGROUND

The effect of disease on health is rapidly increasing because of alterations to the environment, climate change, lifestyle, and other factors. This has increased the risk of ill health. Approximately 3.4 million people died in 2016 due to chronic obstructive pulmonary disease (COPD), affected generally by pollution and smoking, whereas 400,000 people pass away from asthma. The risk of lung diseases is enormous, especially in developing and low middle income countries, where millions of people are facing poverty and air pollution. According to the estimation of WHO, over 4 million premature deaths occur annually from household air pollution-related diseases, including asthma, and pneumonia. Hence, it is necessary to take necessary steps to reduce air pollution and carbon emission. It is also essential to implement efficient diagnostic systems which can assist in detecting lung diseases. Since late December 2019, a novel corona virus disease 2019 (COVID-19) has been causing serious lung damage and breathing problems. In addition, pneumonia, a form of lung disease can be due to the causative virus of COVID-19 or may be caused by other viral or bacterial infection. Hence, early detection of lung diseases has become more important than ever. Machine learning and deep learning can play a vital role for this purpose. Recently, digital technology has become more important worldwide. This research paper can provide doctors and other researchers a direction for detecting lung disease with the help of deep learning methodology. A large number of lung X-ray images are used as a dataset. The system presented herein can also assist to detect diseases more accurately, which can protect numerous vulnerable people and decrease the disease rate. The health scheme is not yet established due in part to population growth . Many researchers have done investigations to relate machine learning schemes for prediction of X-ray image diagnostic information. With the control of computers along with the huge volume of records being unrestricted to the 5 public, this is a high time to resolve this complication. This solution can put up decreasing medical costs with the enlargement of computer science for health and medical science projects. For the implementation, the NIH chest X-ray image dataset is collected from Kaggle repository and it is fully an open-source platform. A new hybrid algorithm is introduced in this paper and this algorithm is successfully applied on the above-mentioned dataset to classify lung disease. The main contribution of this research is the development of this new hybrid deep learning algorithm suitable for predicting lung disease from X-ray images. Section headings should be left justified, bold, with the first letter capitalized and numbered consecutively, starting with the Introduction.

1.5. PROBLEM STATEMENT

Lung diseases are considered to be frequently occurring medical anomalies. Many of the people suffer from various types of lung diseases in India. Genetics, infections and smoking are probable cause for such diseases. The lungs are vital organs that expand and relax many times each day to expel

carbon dioxide and breathe oxygen. About 3million deaths occur every year due to Lung diseases around the world. It is the leading cause of death among young people, especially children. This number can be reduced in a significant amount in the coming future. This could be possible if the type of disease is detected accurately as every other disease has other treatment. There are possibilities that one disease could be mistaken for another. Designing a typical Lung Diseased testing Deep Learning model is going to help rule out these possibilities of errors and help save lives when given proper treatments at appropriate time. Also people in rural areas have limited access to both doctors and specialists.

1.6. MOTIVATION

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1.7. SCOPE OF THE PROJECT

Compared with existing Machine learning and deep learning-based methods, Effectiveness of this new enhanced learning- based method is demonstrated by using Inception V3 and Convolution 2Dimensional Neural Network which is found to be consistent and which algorithm gives the maximum efficiency.

2. METHODOLOGY

2.1 DATA COLLECTON

NIH Chest X-ray – NIH Chest X-ray dataset which is a large public dataset for chest radiograph interpretation, consisting of 5606 chest radiographs. It is a collection of chest radiographic examinations provided by National Institute of Health Care, America performed between October 2002 and July 2017, along with their associated radiology reports. These are used to train our model using deep learning. It carries 5606 images where the resolution of each image is 1024 *1024. In sample labels.csv file contains Patient ID, Finding labels such as disease type ,Image index, View position: X-ray orientation ,Patient gender , Patient age , Original Image Height , Original Image Width ,Original Image Pixel Spacing ,Follow-up ,Original Image Pixel Spacing_y. The description of the class are as follows. There are 15 classes (one is “No findings” and another 14 diseases) in the complete dataset, but subsequently this is severely compact version of the complete dataset, various classes are scarce marked as “No findings”: Atelectasis-508 images, Pneumonia-62, Hernia-13 images, images, Edema-118 images, Emphysema-127 images, Cardiomegaly-141 images, Fibrosis-84 images, Pneumothorax-271 images, Consolidation-226 images, Pleural Thickening-176 images, Mass 284 images, Effusion - 644 images, Infiltration 967 images, Nodule-313 images. These images and csv file is loaded in python.

2.2 DATA PROCESSING

INPUTDATA

In csv file there is a patient age column. Here ages are represented as years, months and days for some of the data. So they are converted to same format which is in the of year. If age is in month it is divided by 12 If age is in days it is divided by 365.Then Then 14 diseases are categorized as Findings and others are categorized as no findings. Then Gender column is splitted into Male and Female. Then view position also splitted as AP and PA. Finally the input data is constructed (5606, 5) which is having the column normalized age, male, female, AP and PA. Posterior-anterior (PA) position- It is a standard position used for finding a regular mature chest radiograph. Patient attitudes standing with the anterior position of chest employed alongside the anterior of the film. The containers are replaced forward adequate to bit the film, confirming in which the scapulae do not make unclear any part of the lung areas. The PA film is observed as if the lung disease patient is fixed in a position. Anterior-posterior (AP) position-It is conducted while the patient is immobilized, debilitated, or incapable to collaborate with the PA process. The heart is at a bigger space from the film. Therefore, it seems more expanded than in a PA position. The scapulae are generally visible in the lung fields for the reason that they are not replaced out of the vision in a PA.

2.3 CNN MODEL

CNNs are neuro biologically-driven by the findings of locally sensitive and orientation-selective nerve cells in the visual cortex. They are a multi-layer neural network. They implicitly extract relevant features. They are a feedforward network that can extract topological features from images. They recognize visual patterns directly from pixel images with minimal preprocessing. They are astonishingly powerful because they can easily recognize patterns that have extreme variability. e.g., hand- writing. CNNs are trained with a version of the back propagation algorithm. CNNs have the neuronal cells in the visual cortex, making the base behind CNNs and watches for particular features.

Sequential layer

Sequential is the easiest way to build a model in Keras. It allows you to build a model layer by layer. We use the 'add ()' function to add layers to our model.

Convolutional 2Dlayer

This layer creates a convolution kernel that is wind with layers input which helps produce a tensor of outputs. It has filters, kernel size and activate 24 function as main parameters. Filters- integer value and also determines the number of output filters in the convolution. it is always recommended to use powers of 2 as the values. Kernel size-This parameter determines the dimensions of the kernel. Common dimensions include 1×1, 3×3, 5×5, and 7×7 which can be passed as (1, 1), (3, 3), (5, 5), or (7, 7) tuples. Activation-The activation parameter to the Conv2D class is simply a convenience parameter which allows you to supply a string, which specifies the name of the activation function you want to apply after performing the convolution.

Maxpooling2Dlayer

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. It has a argument as pool size.

Flatten layer

Flattening is converting the data into a 1-dimensional array for inputting it to the next layer. We flatten the output of the convolutional layers to create a single long feature vector. And it is connected to the final classification model, which is called a fully-connected layer. Dropout Dropout is a technique used to prevent a model from overfitting. Dropout works by randomly setting the outgoing edges of hidden units (neurons that make up hidden layers) to 0 at each update of the training phase. It has one parameter as rate. There's some debate as to whether the dropout should be placed before or after the activation function. As a rule of thumb, place the dropout after the activate function for all activation functions other than relu. In passing 0.25, every hidden unit (neuron) is set to 0 with a probability of 0.25. In other words, there's a 25% change that the output of a given neuron will be forced to0.

Dense layer

The dense layer is a neural network layer that is connected deeply, which means each neuron in the dense layer receives input from all neurons of its previous layer. The dense layer is found to be the most commonly used layer in the models. In the background, the dense layer performs a matrix-vector multiplication. The values used in the matrix are actually parameters that can 25 be trained and updated with the help of back propagation. The output generated by the dense layer is an 'm' dimensional vector. Thus, dense layer is basically used for changing the dimensions of the vector. A dense layer also applies operations like rotation, scaling, translation on the vector. Batch Normalization Batch normalization is a layer that allows every layer of the network to do learning more independently. It is used to normalize the output of the previous layers. The activations scale the input layer in normalization. Using batch normalization learning becomes efficient also it can be used as regularization to avoid overfitting of the model

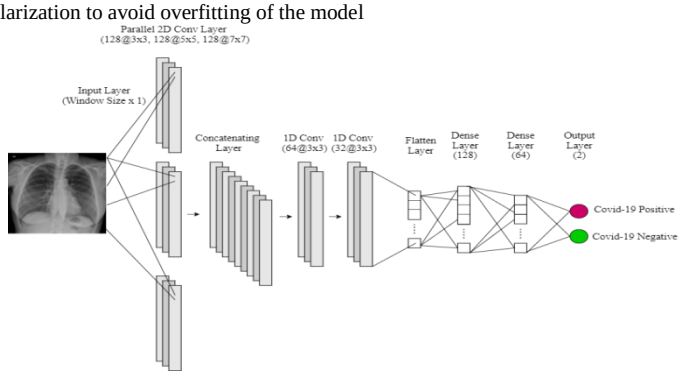

Figure 1CNN Architecture

3. CONCLUSION

In this project, Inception V3 and Convolution Neural network is implemented. As a result 94% accuracy got and losses around 20%. Therefore, hybrid systems have been executed in order to improve the accuracy without increasing the training time. The results described in the paper recommend that the deep learning models can be utilized to improve the diagnosis compared to the traditional methods. As a result, the quality of the affected patient's treatment can be improved

4. Acknowledgement

With immense pleasure, we are publishing this paper as a part of the curriculum of B.Tech. Computer Science & Engineering. It gives us proud privilege to complete this paper work under the valuable guidance of Principal for providing all facilities and help for smooth progress of paper work. We would also like to thank all the Staff Members of Computer Science & Engineering Department, Management, friends and family members, Who have directly or indirectly guided and helped us for the preparation of this paper and gives us an unending support right from the stage the idea was conceived

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