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DETECTION OF THE NOVEL CORONA VIRUS COVID-19 WITHPNEUMONIA AND COVID CHEST X-RAYS USING CONVOLUTIONAL NEURAL NETWORKS

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Abstract

The world is battling the pandemic of Covid-19 at the moment and even after 3 years of Covid pandemic our technology still is not fairly advanced to tackle the battle against this virus in the most efficient way. Covid cases over the entire world as of now has crossed the 420 million marks with the deaths tallying up to 5.8 million. The Covid virus infects a person with several types of symptoms, one such symptom is pneumonia. A person who is having Pneumonia might or might not be having the Covid virus with him/her. This project is tar- geting to filter out the patient X-Rays who have pneumonia and our subjected to have the Corona Virus as well. This system is based on Deep Learning and the method of Convolutional Neural Networks is applied over it. The project is briefly compiled and has a lot of pre-processing to deal with. The project is done with additional help from the frameworks Tensorflow and keras. Firstly, the im- ages are loaded into the compiler and then they are cleaned and pre-processed accordingly. The next comes up with setting up the neural network layer. The CNN layer is built and a special activation function ReLu is applied over it. Fi- nally, the model is trained and a classification is done to find whether the patient X- Ray is only for pneumonia or its of Pneumonia + Covid. The project has an accuracy of over 96% to 98%

Keywords: COVID-19, Convolutional Neural Network, Deep Learning, X-Rays, Pneumonia.

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1 Introduction

Initially the corona virus is declared a pandemic by WHO is 2019. The virus found in Wuhan, China. The virus then was transmitted to the entire world. The virus is a communicable virus and has infected over 420 million people in this entire planet. The virus mutates with time causing different symptoms in people. Some noted minor symptoms are Cough, Fever, Cold, Diarrhoea, loss of smell and taste. Some major symptoms include Pneumonia and Lung Lesion. This project is dealing with the Pneumonia symptoms and figuring out a proper classification of Pneumonia patients and patients having pneumonia as a result of Corona Virus presence.

This project is dealing with Pneumonia X – Ray reports and will classify the X-rays into Covid [14] Patients and normal Pneumonia patients. The method and applications of Deep Learning is used to train the images in bulk and the method of Neural Networks Specifically Convolutional Neural Network is applied. Convolutional Neural Network is a method of Deep Learning [8-12] which is majorly used to train and work on datasets which contains images. Here the images are in form of X-rays. With over 1002 images in the dataset, the model will be trained accordingly to classify the X-Rays.

The dataset has over 575 images for Covid 19 sample lungs X-ray and 427 of Pneu- monia X-Rays. These images will be pre-processed and trained to filter out the selected images into Covid Patients and non-Covid patients. This model has the tendency to predict over thousands of X-Rays in just a second's time and help the doctors and the front-line workers save enough time to manually go through the X-Rays and filter out the patients.

Fig. 1. Covid Chest X-Rays

In fig.1, the X-Rays images for Covid infected lungs can be seen with over 575 sam- ple training images for it. Many inferences can be manually made out by looking over the X-Rays and it shows that there is cloudy type presence in the lungs which signifies the major presence of Corona Virus in the lungs. Fig. 2 depicts sample Pneumonia Chest X-Rays.

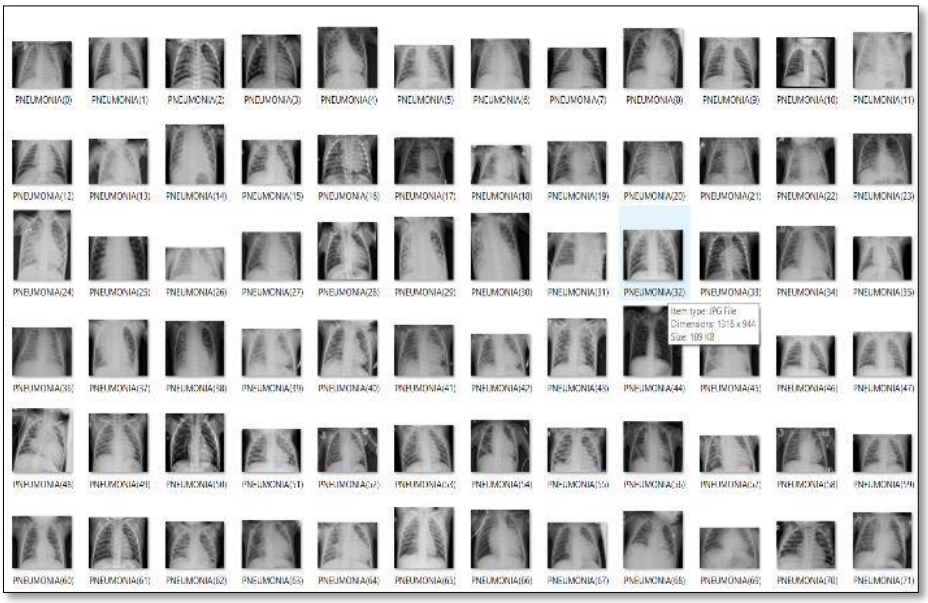

Fig. 2. Pneumonia Chest X-Rays

The goal of the project is to train, identify and classify the X-Ray images into cate- gories of Pneumonia patient and Covid 19 Patient. Here, Category 1 was Covid 19 Patients and Category 2 was Pneumonia only patients.

2 Literature Survey

The author [2] has briefly explained on how does a Convolutional Neural Network

[13] operates from a mathematical perspective. It has made the argument of the use of vectors and matrix to chain out images that are used in the model. The author has also specified the activation function that is applied on every element of the input. Empha- sizes on ReLU layer has been shown below as in fig. 3.

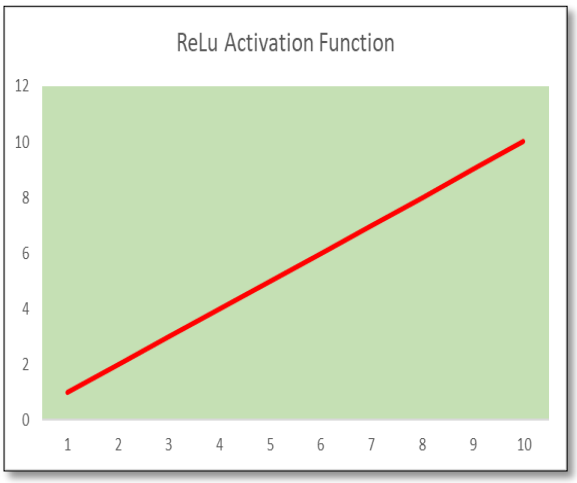

Fig. 3. Rectifier Linear Unit Function

In [1] the author explains 2 main aspects of this project. Firstly, the importance of a non-linear function at the end of a Convolutional layer and secondly why it's better to use 2-layer cascade system. Fig 4. depicts a sigmoid activation function.

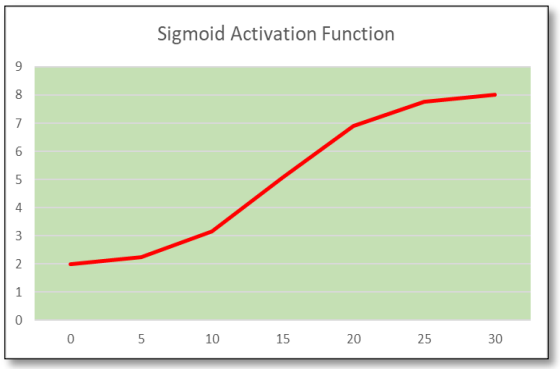

Fig. 4. Sigmoid Activation Function

[6] showed how Pooling occurs and how are images pixel wise classified and then objects are recognized. It shows the architecture of the feature extraction and classifi- cation system. In the research work [7], a practical feature extraction and classification technique is suggested for handling data acquisition besides data fusion to enhance treatment related data.

In [4] the authors have explained about the layers inside a CNN. It was shown that the models do need to have a certain number of layers inside them to create a well- trained network. Theoretically it was said that the more the number of layers the better the

training of the model will be. This thesis was proved wrong when a comparison for a certain model was done by creating a 20-layer model and a 56-layer model. The error percentage graph showed that the model with 56 layers showed significantly more error

percentage than the model with 20 layers. The reason for this was creating noise through feature extraction unnecessarily and overpopulating it.

The author [5] has showed the importance of Batch Normalization in training. To reduce computing time, we batch train the images and to train in more efficient way here it has been shown how it can be achieved by normalization.

Every input distribution changes 10 its state and form when it is sent to the next layer and so it carried on. It makes it hard to train models or images with non-linearity. The author solved this problem with the idea of Batch normalization of every training batch and in this way the few images that were difficult to train due to nonlinear structure the issues was successfully solved. A normalized weight now was assigned to the model batch.

[3] Here it was described about the importance and the need of converting our 2- dimensional array of computed images into 1 dimensional array of images. It was shown that the activation functions are applied in a more efficient way and it also helps in removing redundancy of data as well as faster computing time is achieved. This method was tested and it was found that the accuracy was not lost and hence the signif- icance of flattening was justified which helped in faster computing time. On an average a flattened model provides almost 2 times the speed of non-flattened model.

3 Architecture of the Model

Below is a detailed explanation on system architecture as in fig. 5. of the model created for this work.

3.1 Software Model

The model has taken the basic and important Deep Learning frameworks in use. Tensorflow. Tensorflow is used to create the Convolutional Neural Network and Keras is used to pre-process the images accordingly.

The only algorithm which is working over the process inside Convolutional Network is Backpropagation Algorithm which is done to adjust the weights when training.

3.2 Dataset

Dataset is a game player factor for any project. The dataset used for the prediction is taken from an independent author in Kaggle and the dataset is named "Chest X-ray (Covid-19 & Pneumonia)".

Table 1: Input Dataset

Dataset	Number of Images
COVID-19	575
Pneumonia	427

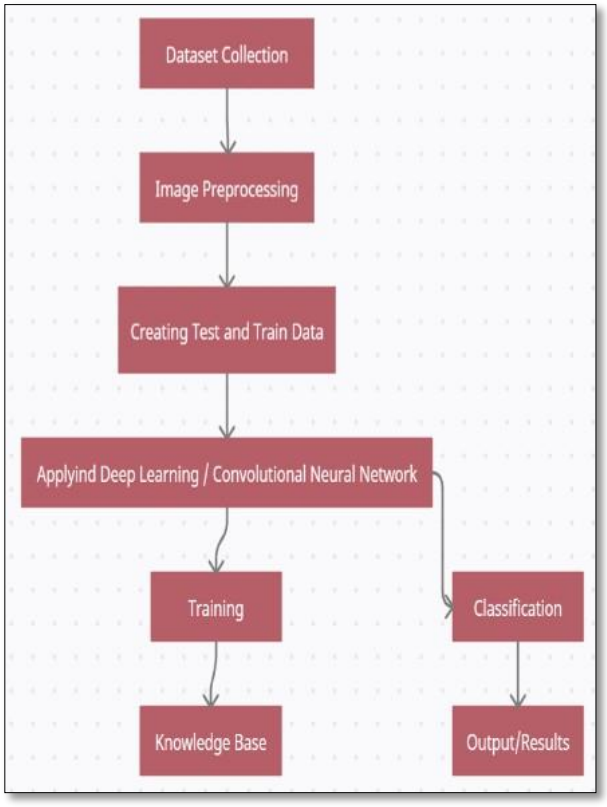

Fig. 5. X-ray Covid Detection Methodology

3.3 Preprocessing

For the preprocessing we have used Keras module. Here, the input image is first read.

The features are detected and represented using the feature map. A convolutional layer is created and the ReLU activation function is applied to it and then pooling is applied and flattening is also done.

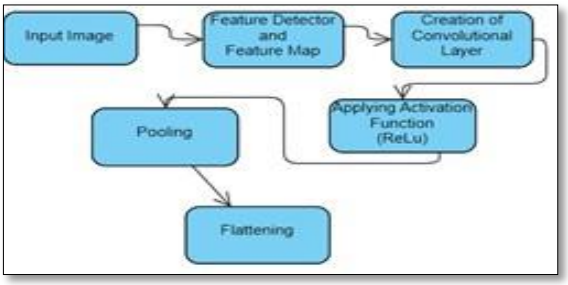

Fig. 6. X-ray Covid Detection overall workflow

3.4 Neural Network Layer

The next step is to set up the convolution layer. Here we will be defining all the techniques for converting our image into 2-D image array which can be understood by the machine. Here we will also be defining convolution techniques like Max-Pooling and Flattening. In the end, the model will be fed as 1-D array and it will be then followed by traditional neural network which will have the hidden layers in order to adjust weights and subsequently train the model.

Fig. 7. Covid Chest X-Ray

The above image in fig. 7 is one of the sample images from the dataset depicting aCovid Chest X-Ray.

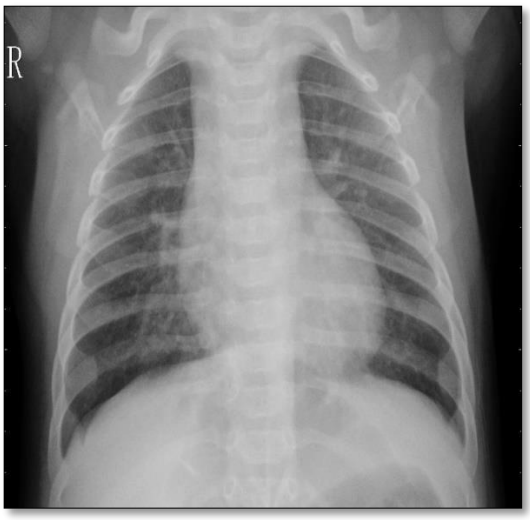

Fig. 8. Pneumonia Chest X-Ray

The above image in fig. 8 is one of the sample images from the dataset depicting a Pneumonia Chest X-Ray.

The Convolutional Layer is shown above in the State Diagram as in fig. 5. Firstly, the input image is fed into the network through which the feature selection is done through detection techniques. The highlighted features are then be made into a feature map. The feature map is then created into several layers known as convolutional layers and an activation ReLU function is applied on it. After the convolutional layer, pooling is done. Finally, the data was converted into 1-D array for inputting it into the next layer and this is known as flattening.

4 Result and Analysis

For this deep learning model, Tensorflow was used to create the convolutional layer and Keras is used to pre-process the images. This is followed by training the model.

The 2-activation functions used in the model are ReLU and Sigmoid functions. The various parameters used by the model as tabulated in table 2.

Table 2: Parameters for the model

Parameters	Choice
Optimizing Method	Adam Optimizer
Loss	Binary Cross Entropy
Metrics	Accuracy
Epochs	10

The model provides an accuracy of 98.04% when we run it on 10 epochs. The below tables, table 3, table 4 and table 5 are for the system where we have a linear activation function and a non-linear activation function, linear and linear activation function and non-linear and non-linear activation functions respectively.

Table 3: Linear and Non-Linear Activation Function

Epoch Number	Loss Value	Accuracy Percentage
1	0.2297	93.55
2	0.0971	96.70
3	0.0786	97.71
4	0.0670	97.99
5	0.0622	97.96
6	0.0626	98.07
7	0.0568	97.99
8	0.0543	98.19
9	0.0554	97.91
10	0.0644	98.04

Table 4: Linear and Linear Activation Function

Epoch Number	Loss Value	Accuracy Percentage
1	1.7934	88.14
2	1.8088	88.14
3	1.8088	88.14
4	1.8088	88.14
5	1.8088	88.14
6	1.8088	88.14
7	1.8088	88.14
8	1.8088	88.14
9	1.8088	88.14
10	1.8088	88.14

Table 5: Non-Linear and Non-Linear Activation Function

Epoch Number	Loss Value	Accuracy Percentage
1	13.5953	11.86
2	13.5953	11.86
3	13.5953	11.86
4	13.5953	11.86
5	13.5953	11.86
6	13.5953	11.86
7	13.5953	11.86
8	13.5953	11.86
9	13.5953	11.86
10	13.5953	11.86

From the above table, table 5 we can depict that as we move along the epoch cycle our model is trained better and the loss metrics gets on decreasing whereas the accuracy keeps on improving. After a certain stage both loss and accuracy show similar data points after every epoch, indicating us that the model is now trained at its best and furthermore any epochs will only increase the computation time and memory usage. It was also noted that our model had both linear and non-linear trends.

The runtime is around 25 minutes. The classification is done on the basis of taking an input image and comparing it with trained Covid X-Rays features. If the image has features of the Covid X-Rays, then it will return the statement that the patient is having Corona Virus or else it will return that the patient is only having Pneumonia.

5 Conclusion

The model is aimed and dedicated to build a system where we can segregate patients into Covid infected pneumonia patients and pneumonia only infected patients. In the present-day scenarios as such with Corona virus pneumonia plays a severe symptom and has infected a lot of people across the world. The model is well trained and gives an accuracy of over 98% when tested. A classification is done in then end in which the

image is then looked upon and its inference points are noted by the machine and the neural network layer. The computing time for training can be improved with better GPU performance which depends on the system a user is using.

References

1. I.D. Apostolopoulos, T.A. Mpesiana, COVID-19: automatic detection from X-ray images utilizing transfer learning with convolutional neural networks, Phys. Eng. Sci. Med. 43 (2) (2020) 635–640, http://dx.doi.org/10.1007/s13246-020-00865-4
2. Sindhu C and G. Vadivu, "Fine grained sentiment polarity classification using augmented knowledge sequence-attention mechanism", in the Journal of Microprocessors and Mi- crosystems, Vol 81, 2021. https://doi.org/10.1016/j.micpro.2020.103365.
3. Jonghoon Jin, Aysegul Dundar, Eugenio Culurciello, "Flattened Convolutional Neural Net- works for Feedforward Acceleration", 2014. https://arxiv.org/abs/1412.5474v4. https://doi.org/10.48550/arXiv.1412.5474
4. Kaiming He, Xiangyu Zhang, Shaoqing Ren, Jian Sun "Deep Residual Learning for Image Recognition" arXiv:1512.03385v1 (2016). CoRR, abs/1512.03385.
5. Sergey Ioffe, Christian Szegedy, "Batch Normalization: Accelerating Deep Network Train-ing by Reducing Internal Covariate Shift", 2015. https://arxiv.org/abs/1502.03167v3. https://doi.org/10.48550/arXiv.1502.03167
6. Dominik Scherer, Andreas M¨uller and Sven Behnke "Evaluation of Pooling Operations in Convolutional Architectures for Object Recognition" in 20th International Conference on Artificial Neural Networks (ICANN), Thessaloniki, Greece, September 2010
7. S. S. Saranya and N. Sabiyath Fatima, "Iot information status using data fusion and feature extraction method," Computers, Materials & Continua, vol. 70, no.1, pp. 1857–1874, 2022
8. A.M. Ismael, A. Şengür, Deep learning approaches for COVID-19 detection based on chest X-ray images, Expert Syst. Appl. 164 (2020) 2021, http://dx.doi.org/10.1016/j.eswa.2020.114054.
9. Y. Oh, S. Park, J.C. Ye, Deep learning COVID-19 features on CXR using limited training data sets, IEEE Trans. Med. Imaging 39 (8) (2020) 2688–2700, http://dx.doi.org/10.1109/TMI.2020.2993291.
10. D. Ezzat, A.E. Hassanien, H.A. Ella, An optimized deep learning architecture for the diag- nosis of COVID-19 disease based on gravitational search optimization, Appl. Soft Comput. 98 (2021) 106742, http://dx.doi.org/10.1016/j.asoc.2020.106742.
11. E. Hussain, M. Hasan, M.A. Rahman, I. Lee, T. Tamanna, M.Z. Parvez, CoroDet: A deep learning based classification for COVID-19 detection using chest X-ray images, Chaos Sol- itons Fractals 142 (2021) 110495, http://dx.doi.org/10.1016/j.chaos.2020.110495.
12. E. Başaran, Z. Cömert, Y. Çelik, Convolutional neural network approach for automatic tym- panic membrane detection and classification, Biomed.Signal Process. Control 56 (2020) http://dx.doi.org/10.1016/j.bspc.2019.101734.
13. C.Y. Wang, H.Y. Mark Liao, Y.H. Wu, P.Y. Chen, J.W. Hsieh, I.H. Yeh, CSPNet: A new backbone that can enhance learning capability of CNN, in: IEEE Comput. Soc. Conf. Com- put. Vis. Pattern Recognit. Work., 2020-June, 2020, pp. 1571–1580, http://dx.doi.org/10.1109/CVPRW50498.2020. 00203.
14. H. Mukherjee, S. Ghosh, A. Dhar, S.M. Obaidullah, K.C. Santosh, K. Roy, Deep neural network to detect COVID-19: one architecture for both CT scans and chest X-rays, Appl. Intell. 51 (5) (2021) 2777–2789, http://dx.doi.org/10.1007/s10489-020-01943-6.