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Detection of Covid-19 from X-Ray Images Using Deep Learning

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***Abstract*: Coronavirus disease 2019 (COVID-19) is a contagious disease caused by severe acute respiratory syndrome coronavirus. It is critical to detect the positive cases as early as possible so as to prevent the further spread of this epidemic and to quickly treat affected patients. To overcome this difficulty, we have developed a model using deep learning to detect covid-19 from x-ray images. This project aims to develop a model using Darknet-19 as a classifier for the you only look once (YOLO) real time object detection system. This project provides accurate diagnostics for binary classification (COVID vs. No-Findings).**

***Keywords*: Covid-19, Deep Learning, Darknet-19, YOLO**

1. Introduction

1) What is Covid-19?

COVID-19 is a respiratory infection caused by the novel coronavirus severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The severity of the disease is related to advanced age and co-morbidities such as chronic heart and lung disease. Additionally, the virus is highly contagious, spreading efficiently by human to human transmission via droplets or close contact. Each infected person is capable of transmitting the virus to 3 other people.

2) Why Deep Learning?

In general, the tests can yield results in a day or within two days, but there are some cases where it takes one or two weeks to get the results. Around 40% of the molecular test results have been false. Deep learning is a class of machine learning algorithms that uses multiple layers to progressively extract higher-level features from the raw input. For example, in image processing, lower layers may identify edges, while higher layers may identify the concepts relevant to a human such as digits or letters or faces. The advent of deep learning technology has revolutionized artificial intelligence. The word deep refers to the increase in the size of this network with the number of layers. Deep learning algorithms can be applied to unsupervised learning tasks. This is an important benefit because unlabelled data are more abundant than the labelled data. Examples of deep structures that can be trained in an unsupervised manner are neural history compressors and deep belief networks. For supervised learning tasks, deep learning methods eliminate feature engineering, by translating the data into compact intermediate representations akin to principal components and derive layered structures that remove redundancy in representation.

2. Objectives

- To provide accurate diagnostics for binary classification (COVID vs. No- Findings) using Dark Covid Net Model (Darknet-19).
- To get fast computation results.

3. Methodology

The proposed model has 15 convolution layers. The batch normalization operation is used to standardize the inputs, and this operation has other benefits, such as reducing training time and increasing stability of the model. LeakyReLU is a variation of the ReLU operation used to prevent dying neurons. Unlike ReLU or sigmoid activation functions, which have zero value in the negative part of their derivatives, LeakyReLU has a small epsilon value to overcome the dying neuron problem. Similar to the Darknet-19 model, the Maxpool method is used in all the pooling operations. Maxpool downsizes an input by taking the maximum of a region determined by its filter. When working with two classes, the proposed model performs the COVID-19 detection task. The developed deep learning model consists of 5,668,097 parameters. After the model is trained, it is ready to detect the covid-19 from the input samples.

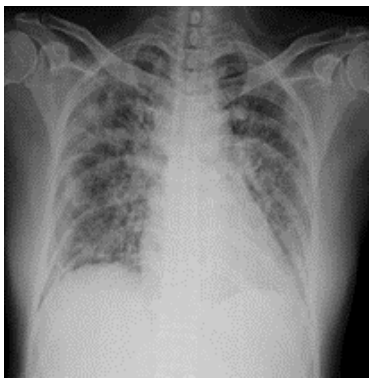

Fig. 1. Sample X-ray Image

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4. Proposed Model

1) Block Diagram

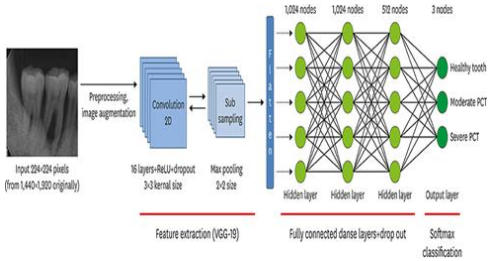

Fig. 2. Block Diagram of covid-19 detection using Darknet-19 Model

2) Dataset

In this Project, X-ray images obtained from two different sources were used for the diagnosis of COVID-19. A COVID-19 X-ray image database was developed by Cohen JP using images from various open access sources. At present, there are 130 X-ray images diagnosed with COVID-19 in the database. Also, the Chest X-ray images which are not diagnosed with COVID-19 provided by Wang et al was used for No-Finding Cases.

3) Image Preprocessing and data generation

Image Preprocessing is used to transform raw images into understandable format. Preprocessing involves scaling the pixel values of image and data augmentation. Data augmentation means artificially producing brand new training data from the already existing training data. The intent is to expand the training data with new samples. For example, changing the direction, position and alignment of the object.

4) Darknet-19

Darknet-19 is the classifier model that forms the basis of a real-time object detection system named YOLO (You only look once). These layers are typical CNN layers with different filter numbers, sizes, and stride values.

5) Convolution Layer

A convolution is a combined integration of two functions that shows you how one function modifies the other. Convolutional neural networks apply a filter to an input to create a feature map that summarizes the presence of detected features in the input.

6) Max Pooling Layer

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.

7) Flattening Layer

Once the pooled featured map is obtained, the next step is to flatten it. Flattening involves transforming the entire pooled feature map matrix into a single column which is then fed to the neural network for processing.

8) Training the fully connected Darknet Neural Network

The model was trained by using 488 images which are belonging to 2 different classes in the training data, and 137 images which are belonging to 2 different classes in the test data. The flattened output is fed to a feed-forward and fully connected artificial neural network layer and back-propagation method is applied over each iteration of training. Sigmoid and Avgpool layers are used for output classification. The fully connected neural network improves the quality of the model and in every iter ation, parameters approach to the values which satisfy better accuracy. Over a series of epochs, the model was able to differentiate between certain dominating features in images.

9) Prediction

After the model is fitted, we can use the Predict method to make predictions using new images.

Table 1
Epoch vs Accuracy

Epochs	Accuracy
1	0.7812
2	0.8125
3	0.8125
4	0.8125
5	0.9219
6	0.9219
7	0.9219
8	0.9688
9	0.8281
10	0.8906

5. Output

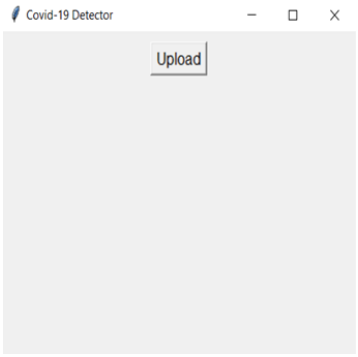

Fig. 3. Output window

1) COVID-19 Positive

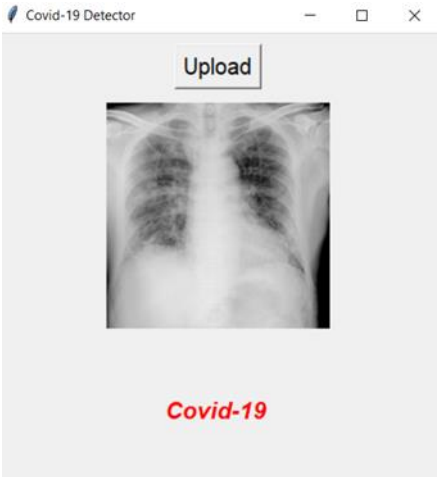

Fig. 4. Output window for COVID-19 case

2) No Findings

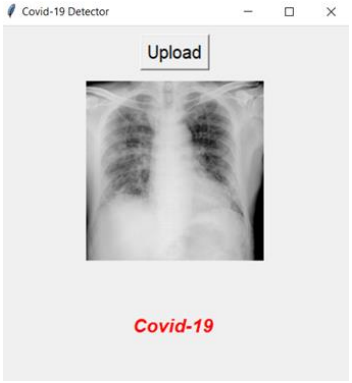

Fig. 5. Output window for COVID-19 No Findings case

6. Conclusion

The main objective of this project is to produce higher accuracy in diagnosis of binary classification. Our model produced a maximum accuracy of 96.88% from the given samples. Two separate folders are created for Covid-19 and No finding cases. After the detection the input X-Ray image is automatically moved to the respective folder which helps the radiologists/doctors to identify the cases easily when large number of X-Ray images are uploaded.

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