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Web App for Pneumonia Detection using Flask and VGG16

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Abstract: *Today in the medical field lot of complications have arrived in this fields. The reason is that the human body has innumerable parts. As the people are become advanced day by day and they move towards automation for their comfort. The machines have become smarter due to high computation power. The machines have become accurate as the data is available in large quantity. Therefore machines are essential for human work. Decisions taken by machines are more reliable than man. So, here we try to build machine learning model to detect pneumonia. The pneumonia is detected using examine of chest X-Ray radiograph by highly-trained specialists. The result can be different according to different radiologists. Examining chest X-Ray requires high precision. Covid-19 can cause Pneumonia. Pneumonia is a disease that affects the lungs. We aim at designing a highly efficient system to predict a user suffers from Pneumonia by analyzing the patient's chest X-ray images and increasing the accuracy of the system by use of CNN.*

Keywords: VGG16, Keras, Tensorflow, Matplotlib, Flask

I. Introduction

Many diseases are passed down to the next generations because of their Genes. Out of total children deaths, 16% of the deaths are caused be Pneumonia. In the United States only, about 1 million adults seek care in a hospital due to pneumonia every year, and 50,000 die from this disease. The pneumonia complicating recent corona virus disease 2019 (COVID-19) is a life-threatening condition claiming thousands of lives in 2020**.** Normally Pneumonia is detected by chest XRay by a radiologist. It is the area of increased opacity in the XRay. Our approach uses convolution neural networks (CNN). The algorithm automatically locates lung opacities on chest radiographs and it is one of the best performances in the challenges.

II. System Implementation

The following section gives the details about how the problem will be solved by us. The goal is to find the best solution through analysis. Initially we have to focus on data. Since there may be large variability in the datasets, containing high anomaly values and other white noises.

2.1 Proposed Network

In this study, we designed a VGG-based CNN model to extract the features of chest X-ray images and use those features to detect if a patient suffers from pneumonia.

Let xi be the input or the ith hidden layer feature map, $1 \leq i \leq N$, N represents all layers of the model and in our architecture, set $N = 6$, meaning our model contains six hidden layers. $C_i(\cdot)$, $1 \leq i \leq 4$, represents convolution operation whose kernel size and strides are 3×3 and 1×1, respectively. Wi , $1 \leq i \leq N$, represents the weight matrix of the ith layer; bi represents bias value of the ith layer;

$$\psi_i = \begin{cases} \text{ReLU}, & 1 \leq i \leq 5, \\ \text{Sigmoid}, & i = 6 \end{cases}$$

where Sigmoid and ReLU are activation functions. $D_i(\cdot)$, $2 \leq i \leq 5$ represents the drop operation, which aims to randomly set the value of hidden layers or neuron to zero and improve the performance of model. $M_i(\cdot)$, $1 \leq i \leq 4$ represents the max-pooling operation, aiming to reduce the computation of the model and improve its robustness; $FC_i(\cdot)$, $5 \leq i \leq 6$ represents the fully-connected operation. So the i + 1th output of model is

$$x_{i+1} = M_i(D_i(\psi_i(C_i(W_i x_i + b_i))))$$

The last layer outputs final decision y∈{0,1}, indicating the absence or presence of disease, respectively.

2.2 Pre processing

Here the input image data is converted into meaningful floating-point values. The flo00ating point value represents 64x64 images having 3 channels and will have dimensions (64,64,3). The algorithm reads the image. Decodes the images to RGB grids. These floating point values are inputs to neural network.

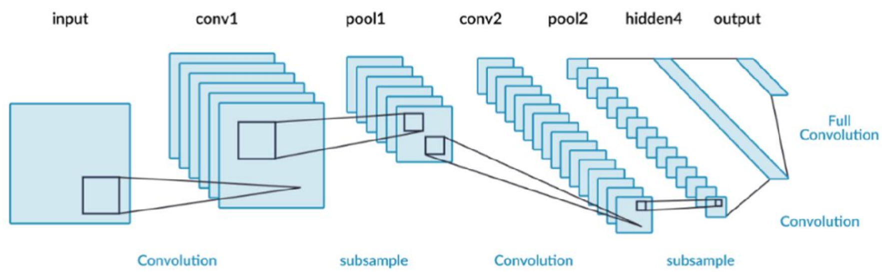

Figure 1: Architecture of CNN

2.3 Classification Evaluation Metrics

In this subsection, several evaluation metrics, accuracy, precision, recall, F1 score and so on, are described. According to the outputs of model, four indices, True Positive, True Negative, False Positive, False Negative, are used to analyze and identify the performance of model. The True Positive means that the chest X-ray images, which suffer from pneumonia, are signed as pneumonia as well by the model. The True Negative means if the chest X-ray images do not show pneumonia as well as the model predicts. The remaining matrices have a similar definition. The four metrics are given as follows:

$$\text{accuracy} = \frac{TP + TN}{TP + TN + FP + FN}$$

$$\text{precision} = \frac{TP}{TP + FP}$$

$$\text{recall} = \frac{TP}{FP + FN}$$

$$F1 = 2 \times \frac{\text{precision}}{\text{precision} + \text{recall}}$$

TP, TN, FP and FN mentioned by the above formulas are True Positive, True Negative, False Positive, and False Negative, respectively. Among the four metrics, the precision rate was always used to estimate how much the number of images that are truly pneumonia accounted for in the total number examples, which are classified as positive for pneumonia. That is, the pneumonia images must be identified in practical clinical diagnoses and hence, the precision rate is especially important. In most cases, the higher the precision rate gets, the lower the recall rate is. Thus, F1 score rate is widely considered as a proper criterion. In addition, the Receiver Operating Characteristic (ROC) and AUC are calculated to compare the performance of different models. The whole training procedure will be displayed in this section. First, the hyper-parameters are fixed . In our architecture, we optimize the model by Adam optimizer, an algorithm for stochastic optimization; the learning rate and the learning rate decay per epoch were set to 0.001 and 0.0001. Then, the hidden layer activation function and last classification activation function are set to ReLU and Sigmoid, respectively.

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Parameters	Value
Optimizer	Adam
Learning Rate	0.001
Learning Rate Decay Per Epoch	0.0001
Batch Size	16
Hidden Layer Activation Function	ReLU
Classification Activation Function	Sigmoid

2.4 Model Training

VGG16 is a convolution neural net (CNN) architecture which was used to win ILSVR(Imagenet) competition in 2014. Most unique thing about VGG16 is that it is focused on having convolution layers of 3x3 filters with a stride 1 and always used same padding and maxpool layer of 2x2 filter of stride 2. It follows this arrangement of convolution and max pool layers consistently throughout the whole architecture. In the end it has 2 FC(fully connected layers) followed by a softmax for output. The 16 in VGG16 refers to it has 16 layers that have weights. This network is a pretty large network and it has about 138 million (approx) parameters.

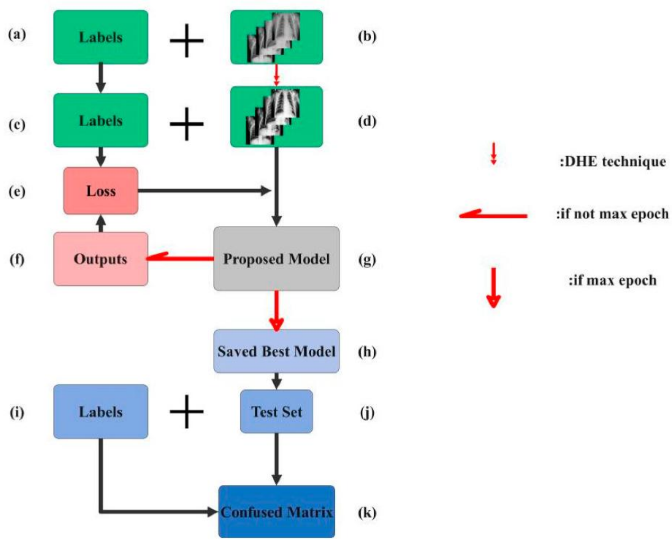

Figure 4: VGG16 model internal Architecture

Below model shows the operation performs on different layers. layers like input Layer, conv2D layer ,Maxpooling2D Layer and gives the Output shapes and total trainable and non-trainable Params after performing operations

Model: "model"

Layer (type)	Output Shape	Param #
input_1 (InputLayer)	[(None, 224, 224, 3)]	0
block1_conv1 (Conv2D)	(None, 224, 224, 64)	1792
block1_conv2 (Conv2D)	(None, 224, 224, 64)	36928
block1_pool (MaxPooling2D)	(None, 112, 112, 64)	0
block2_conv1 (Conv2D)	(None, 112, 112, 128)	73856
block2_conv2 (Conv2D)	(None, 112, 112, 128)	147584
block2_pool (MaxPooling2D)	(None, 56, 56, 128)	0
block3_conv1 (Conv2D)	(None, 56, 56, 256)	295168
block3_conv2 (Conv2D)	(None, 56, 56, 256)	590080
block3_conv3 (Conv2D)	(None, 56, 56, 256)	590080
block3_pool (MaxPooling2D)	(None, 28, 28, 256)	0
block4_conv1 (Conv2D)	(None, 28, 28, 512)	1180160
block4_conv2 (Conv2D)	(None, 28, 28, 512)	2359808
block4_conv3 (Conv2D)	(None, 28, 28, 512)	2359808
block4_pool (MaxPooling2D)	(None, 14, 14, 512)	0
block5_conv1 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv2 (Conv2D)	(None, 14, 14, 512)	2359808
block5_conv3 (Conv2D)	(None, 14, 14, 512)	2359808
block5_pool (MaxPooling2D)	(None, 7, 7, 512)	0
flatten (Flatten)	(None, 25088)	0
dense (Dense)	(None, 2)	50178

Total params: 14,764,866
Trainable params: 50,178
Non-trainable params: 14,714,688

Figure 4: VGG16 model internal Architecture

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III. Result of VGG16

The result is that the model trained has the accuracy of 96% as compared to XCeption which is of 70.34% and ResNet-50 of 77.49%. If the result is received '0' then "Affected by Pneumonia" is given on the Output Screen otherwise result is given normal. The result obtained here is given to the Front end of the Web based app.

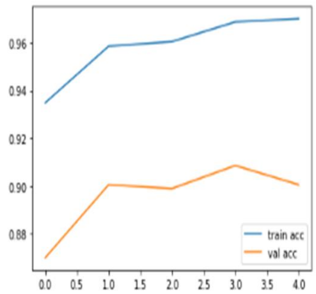

Fig 5. Accuracy Graph

```
img=image.load_img('D:/00 PROJECT 00/chest_xray/train/NORMAL/IM-0141-0001.jpeg',target_size=(224,224))
x=image.img_to_array(img)
x=np.expand_dims(x, axis=0)
img_data=preprocess_input(x)
classes=model.predict(img_data)
result=int(classes[0][0])
if result==0:
    print("Person is Affected By PNEUMONIA")
else:
    print("Result is Normal")

Result is Normal
```

Fig 6. Results of the model after comparing with the trained model

IV. Algorithm

4.1 Login

Initially user creates the account on the system by register themselves in system and then logs in into system and access their account and gives permission to upload his XRay image for detection.

4.2 Data Upload

After that user should enter the requested data and upload his XRay image to for the model to get the results and wait.

4.3 Comparing with Trained Model

The user's uploaded chest x-ray will be compared with trained model and it display the outcome result.

4.4 View Results

On the output screen the user will get the result whether it is "Affected by Pneumonia" or "Normal".

4.5 Doctor Opinion

We also provide system access to doctor so after getting result user can also take consultation from doctor

V. Results

In this project we have built a Python Flask web app. Accuracy achieved by us is of 96%.

VI. Conclusion

The system will provide the final result that whether that person is having pneumonia or not. It will also gives high accuracy.

Acknowledgment

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