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Diabetic Retinopathy Detection using Pretrained Models of Deep Learning

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***Abstract*—Diabetic Retinopathy (DR) is a type of disease related to eye caused by diabetes. It is one of the reason for blindness. Detecting retionopathy is very essential process in reducing partial blindness of patients. Identifying DR consumes time and involves lot of manual process by opthamologist. Detection of DR helps in taking quick decisions. This paper discloses automated binary classification system over 388 retina images(healthy and severeDR).This automated classification system is based on pretrained models VGG-16 and VGG-19 of deep learning with convolution neural network.Though there are many intelligent system ,clarity in the images plays a vital role.This automated classification system is build with minimal code using pretrained model and KNIME analytical platform.**

The proposed system achieves around 91% with both VGG16 and VGG-19 with fewer image preprocessing steps.

***Index Terms*— Diabetic retinopathy, KNIME, Deep learning, CNN, Classification.**

I. INTRODUCTION

Diabetic Retinopathy(DR) leads to permanent blindness. Diabetes causes damage to the area at the back of the eye which is retina ,this is called diabetic retinopathy[14].In India about 3 million people aged above 40 are suffering from vision threatening diabetic retinopathy. Diabetic retinopathy attacks 30 percent of diabatic patients. It is considered to be the most severe cause for loss of vision[9]. Around 80 percent of total vision loss is associated with diabetic retinopathy. Conventional way to detect DR have been used since long time. Patients visiting hospitals with DR complaints undergo conventional DR detection procedures. Patients and doctors need to wait for the results from conventional DR detection procedures. These procedures being time consuming there is a need for alternate means to detect DR in faster manner. Conventional method consume 7 to 14 days to detect DR.

For detecting DR ,one of the deep learning[11][13] concepts convolutional neural network(CNN)[7][8] is used for processing and classifying the images as shown in fig 1. CNN[16] consists of multiple layers and the layers which make it unique are convolution layer and pooling layer. Fully connected layer allows to perform classification on dataset. Convolutional layer works by placing a filter over an array of image pixel which results in feature map. Next is the pooling layer(max pooling or Global average pooling[18]) which reduces the size of a

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particular feature map. This makes processing much faster as the number of parameters that the network needs to process are minimised. Final step is to flatten the things as neural network can process only linear data.

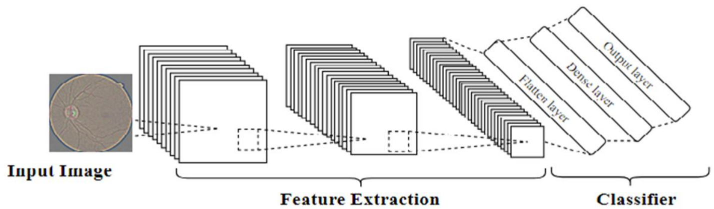

Figure 1: Pre Trained Models of deep learning architecture

Dense layer consists of the activation function like ReLU. Final output layer consists of the classification function like Sigmoid(for binary classification)
First step is to collect the dataset, then the model is built using pretrained models VGG-16 or VGG-19 along with KNIME nodes. Transfer learning[20] is used which allows to use all or part of a model(VGG-16 or VGG-19) that is already developed on a certain task and using its learnings on a whole new task (Diabetic retinopathy detection) .Following steps are used to perform binary classification of retina images(healthy or severeDR).First read and preprocess the image ,second defining the network architecture ,finally train ,execute and evaluate the network.

II. LITERATURE SURVEY

Dania Rahhal et.al.,[4] used models VGG16 Model ,DenseNet121, ResNet152 Model, InceptionV3 Model, MobileNet Model, InceptionResNetV2 for detection and classification of Diabetic Retinopathy[13] . Dataset consisted of 12,524 coloured images of retina from 9598 patients of all ages. Preprocessing of images is performed and images are classified into 5 categories like No DR, Mild DR, Moderate DR, Severe DR and Proliferate DR[10][12]. The transfer learning model showed superior results and the maximum accuracy was 100% achieved using VGG-16. Guassian blur techniques has been applied to the fundus images. Image enhancement was used so that the clarity of image has increased as required for machine learning. CNN and transfer learning is used.
Hanung Adi Nugroho et.al.,[6] has developed DR classifier for classifying normal and abnormal images. Dataset consisted of 200 retina images(100-normalclass and 100-abnormal class) collected from Sardjito Hospital and Yogyakarta, Indonesia. Proportion of data considered for training and testing is 80:20 . Solution was obtained by following steps like image enhancement, training ,testing and finally evaluation. Deep learning architecture is used to obtain accuracy , sensitivity, specificity of 92,95 and 81% respectively. Experiment consisted of images of size 224*224 with batch size of 16 and different epoch like 10,25,50,85,100 and GoogleNet Model is used.
Quang H. Nguyen et.al.,[5] tested VGG-16 and VGG-19 CNN models and obtained accuracy ranging from 71 to 73% .Convolutional layer, optimiser, dense ,merge were customised to obtain accuracy ranging from 80 to 83%. Dataset is taken from Kaggle which consisted of coloured retina images of left and right eyes . Before image was subjected to training image preprocessing[10] was carried to reduce the noise level. Images are classified into 5 categories 0-No DR,1-Mild,2-Moderate,3-Severe,4-Proliferate DR. before image was subjected to training image preprocessing was carried to reduce the noise level.

III. PROPOSED ARCHITECTURE

Transfer learning [17] has become quite popular field for image processing. Pre trained model is used to retrain for the current dataset. Computation power is saved because changes are only done with respect to the last few layers of the architecture.
Present work includes 2 methodologies. In the first methodology, KNIME Deep learning nodes along with VGG-19 pre trained model code is included in DL Python Network Creator. Dataset is split into 3 different ratios 60:40,70:30 and 80:20 as train and test set respectively.
In the second methodology KNIME Deep learning nodes along with VGG-16 pre trained model code is included in DL Python Network Creator. Dataset is split into 3 different ratios 60:40,70:30 and 80:20 as train and test set respectively. Then the model is executed.

Only difference between VGG-16 and VGG-19 model is the number of convolution layers as shown in the figure (2)

A. VGG-19 and VGG-16 layers

VGG-19 is a CNN that is 19 layers deep and has learned rich feature representations for a wide range of images. Fig 2 represents the layers in the model.
Arguments provided for VGG-19 model.

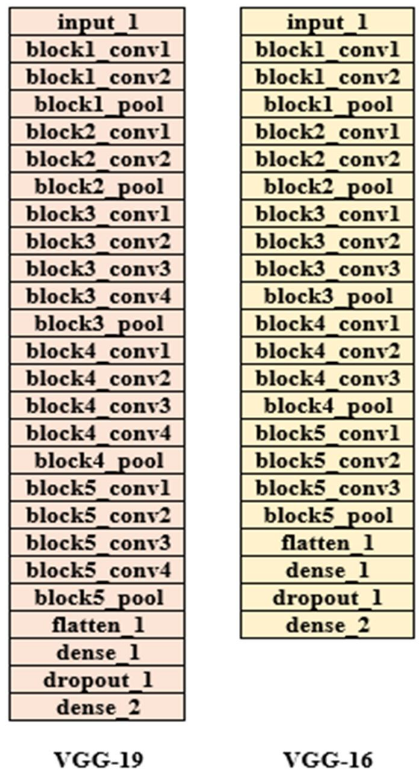

Figure 2: Layers in VGG-19 and VGG-16 model

- include_top: is set to false so that top layers of VGG-19 are excluded
- input_tensor: uses the image input for the model.
- input_shape: since include_top is set to False input shape is set to (150, 150, 3)

Returns

- A keras.Model instance which is assigned to variable of the output network from DL python Network Creator node

VGG-16 is a CNN that is 16 layers deep and has learned rich feature representations for a wide range of images.
Arguments provided for VGG-16 model

- include_top: is set to false so that top layers of VGG-16 are excluded
- input_tensor: uses the image input for the model.
- input_shape: since include_top is set to False input shape is set to (150, 150, 3)

Returns

- A keras.Model instance which is assigned to variable of the output network from DL python Network Creator node

B. Data Source

Dataset needed for analysis is collected from Kaggle website[1]. Dataset consisted of 388 images divided into two classes(healthy class and severeDR class).SevereDR class indicates DR condition.

Fig 3(a)represents healthy retina and fig 3(b) represents SevereDR

Total Class Labels = 2

Total Images = 388

1. Healthy (Not DR) = 198
2. Severe DR = 190

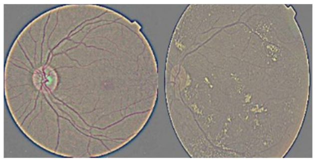

Figure 3:- a): Healthy b):SevereDR

C. Structure of Proposed Model

Model is implemented using KNIME Analytics platform as shown in fig(4) .VGG-19 model code is included in the DL Python Network Creator node. The top layers of pretrained model is removed and new layers are added.

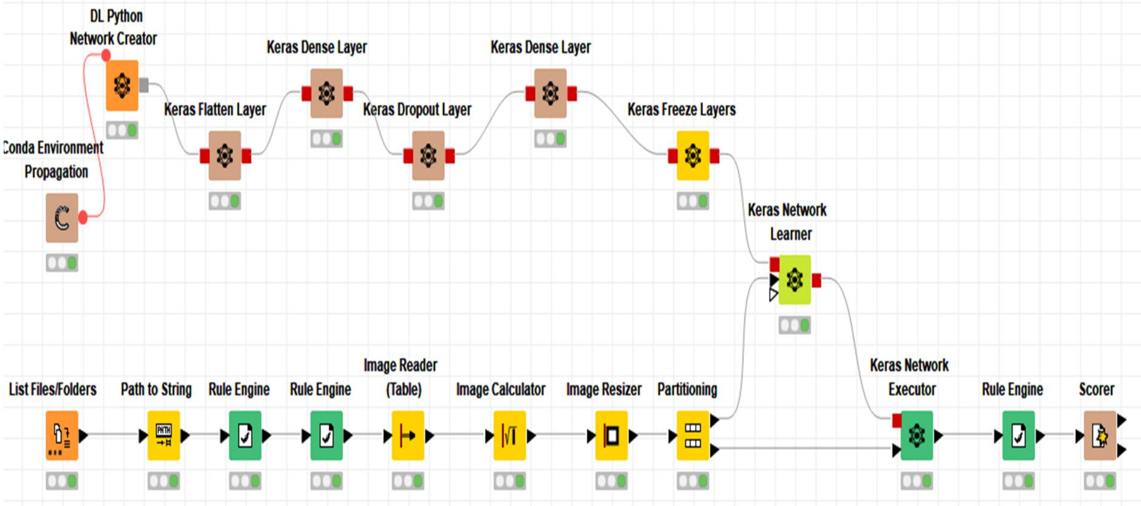

Figure 4: Transfer learning using VGG-19 model for Binary Image classification

Network Architecture nodes are

- Conda Environment Propogation-is used to provide python environment. It contains all the necessary packages related to python.
- DL Python Network Creator: allows the user to specify user defined script . In this model VGG-19 code[3] is written using DL Python network creator.
- Keras Flatten Layer : this layer is used to flatten the output of VGG19 model into single dimension.
- Keras Dense Layer : allows to specify input tensor as well as activation function(ReLU-Rectified Linear Unit) with 32 neurons.
- Keras Dropout layer :used to specify the dropout rate of 0.5 to overcome the problem of overfitting .
- Keras Dense layer : allows to specify input tensor as well as final activation function(Sigmoid- for binary classification).
- Keras Freeze Layer : specifies the number of trainable and not trainable layers.

Reading And Processing Of Image nodes are

- List Files/Folders: used to load the images from the folder.
- Path to string: location or the path of the image is converted into string format which is required for writing rules or conditions using rule engine.
- Rule Engine: node considers user defined conditions or rules to match with each row in the input table
- Image Reader :this node reads the images and transfers them to the image format supported by KNIME

- Image Calculator: node is used to apply mathematical operations on the pixel values of the image.
- Image Resizer : as the name implies it is used to resize the images according to our requirement. In this model images are resized into 150 X 150
- Partitioning: this node is used to partition the given set of images into training set and test set by specifying the ratio of partition as well as sampling method.

Train, Execute and Evaluate Network nodes are

- Keras Network Learner-Once the network is freezed it is given as an input to keras network learner along with the training data (images of shape 150 X 150 and 3 channels).It uses Adam optimiser[19]
- Keras Network Executor-The output of keras network learner is given as input to keras network executor along with testing data (images of shape 150 X 150 and 3 channels)
  Both keras network learner and executor acts as a image classifier.
- Rule Engine :is used to assign probability values to either healthy or severe.
- Scorer: it provides the confusion matrix as well as other evaluation metrics or properties like accuracy,sensitivity,specificity etc.

IV. RESULT ANALYSIS

In this work, metrics for evaluating the performance of proposed models VGG-16 and VGG-19 are formulated as follows:

Accuracy: specifies how close is the predicted value to the target value.

Accuracy=$\frac{TP+TN}{TP+TN+FP+FN}$

Sensitivity: means proportion of TP is high and FN is low

Sensitivity = $\frac{TP}{TP+FN}$

Specificity :means proportion of TN is high and FP is low

Specificity = $\frac{TN}{TN+FP}$

Where as TP- is true and classified as True
TN- is false and classified as False
FP- is false but classified as True
FN- is true but classified as False

Experiment consists of 2 scenarios.

*In the first scenario KNIME Deep learning nodes along with VGG-16 pre trained model is executed with dataset being split into 3 different ratios 60:40,70:30 and 80:20 as training and testing dataset respectively.

*In the second scenario KNIME Deep learning nodes along with VGG-19 pre trained model is executed with dataset being split into 3 different ratios 60:40,70:30 and 80:20 as training and testing dataset respectively.

Results of both the scenarios are mentioned in the table (1).

TABLE I: EXPERIMENTAL RESULTS OF TWO METHODOLOGIES

	VGG-16 Model			VGG-19 Model		
Partition ratio for training and test	60:40	70:30	80:20	60:40	70:30	80:20
Accuracy	90.38	88.9	88.5	89.7	90.6	87.2
Sensitivity	98.7	98.2	94.7	96.1	100	94.7
Specificity	98.7	98.2	94.7	96.1	100	94.7

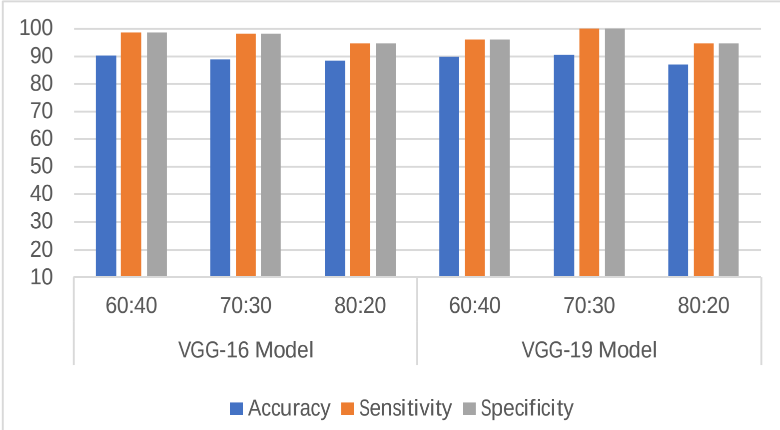

Figure 5 Accuracy,Sensitivity and Specificity of VGG-16 and VGG-19 model

V. CONCLUSION

The proposed system used convolutional neural network pre trained models to classify the images into 2 categories (healthy or severeDR) based on either VGG-16 and VGG-19 pre trained model . The dataset consisting of images is collected from the public repository of Kaggle website. The images are normalised and rescaled before training and testing. The experimental analysis conducted using KNIME analytics tool shows that the VGG-16 and VGG-19 model is having almost similar accuracy , sensitivity and specificity irrespective of partition percentage. The highest accuracy obtained from VGG-19 is 90.6 with the dataset partition 70:30 and the highest accuracy obtained from VGG-16 is 90.38 with the dataset partition 60:40 as shown in fig(5). The model performance may be limited due to lack of clarity in the images. Thus, the model helps to perform any binary classification for medical analysis using the images.

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