

Diabetic Retinopathy Detection

Diabetic Retinopathy Preprocessed Dataset

```
In [ ]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import matplotlib.image as mpimg
import os
import random
import tensorflow as tf
from sklearn.model_selection import train_test_split
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from keras.applications.vgg16 import VGG16
from keras import models, layers
from keras.optimizers import Adam
from sklearn import metrics
import cv2
from keras import regularizers
import keras
```

```
In [ ]: from google.colab import drive
drive.mount('/content/drive')
```

Mounted at /content/drive

Creating Dataframes

```
In [ ]: train_folder = '/content/drive/MyDrive/Train/Train'
all_data = []
for folder in os.listdir(train_folder):

    label_folder = os.path.join(train_folder, folder)
    onlyfiles = [{ 'label': folder, 'path': os.path.join(label_folder, f)} for f in os.listdir(label_folder)]
    #print(onlyfiles)
    all_data += onlyfiles
data_df = pd.DataFrame(all_data)
data_df
```

Out[]:

	label	path
0	Severe DR	/content/drive/MyDrive/Train/Train/Severe DR/S...
1	Severe DR	/content/drive/MyDrive/Train/Train/Severe DR/S...
2	Severe DR	/content/drive/MyDrive/Train/Train/Severe DR/S...
3	Severe DR	/content/drive/MyDrive/Train/Train/Severe DR/S...
4	Severe DR	/content/drive/MyDrive/Train/Train/Severe DR/S...
...
11191	Proliferative DR	/content/drive/MyDrive/Train/Train/Proliferati...
11192	Proliferative DR	/content/drive/MyDrive/Train/Train/Proliferati...
11193	Proliferative DR	/content/drive/MyDrive/Train/Train/Proliferati...
11194	Proliferative DR	/content/drive/MyDrive/Train/Train/Proliferati...
11195	Proliferative DR	/content/drive/MyDrive/Train/Train/Proliferati...

11196 rows × 2 columns

Training

```
In [ ]: img_width, img_height = 128, 128
batch_size = 128
y_col = 'label'
x_col = 'path'
no_of_classes = len(data_df[y_col].unique())
```

```
In [ ]: train_ds = tf.keras.utils.image_dataset_from_directory(
    "/content/drive/MyDrive/Train/Train",
    image_size=(img_height, img_width),
    batch_size=batch_size,
    label_mode="categorical")

val_ds = tf.keras.utils.image_dataset_from_directory(
    "/content/drive/MyDrive/TestingDataset",
    image_size=(img_height, img_width),
    batch_size=batch_size,
    label_mode="categorical")
```

Found 11196 files belonging to 5 classes.

Found 2070 files belonging to 5 classes.

```
In [ ]: base_model = VGG16(weights = "imagenet", include_top = False, input_shape = (128, 1
base_model.trainable = False ## Immutable base model
```

Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg16/vgg16_weights_tf_dim_ordering_tf_kernels_notop.h5

58889256/58889256 [=====] - 2s 0us/step

```
In [ ]: flatten_layer = layers.Flatten()
dense_layer_1 = layers.Dense(512, kernel_regularizer=regularizers.l2(0.01), activation='relu')
dropout_layer_1 = layers.Dropout(0.5)
prediction_layer = layers.Dense(5, activation='softmax')

model = models.Sequential([
    base_model,
    flatten_layer,
    dense_layer_1,
    dropout_layer_1,
    prediction_layer
])
```

```
In [ ]: model.summary()
```

Model: "sequential_2"

Layer (type)	Output Shape	Param #
vgg16 (Functional)	(None, 4, 4, 512)	14714688
flatten_3 (Flatten)	(None, 8192)	0
dense_6 (Dense)	(None, 512)	4194816
dropout_3 (Dropout)	(None, 512)	0
dense_7 (Dense)	(None, 5)	2565

```
In [ ]: classes = 5  
        epochs = 50  
        learning_rate = 0.0001
```

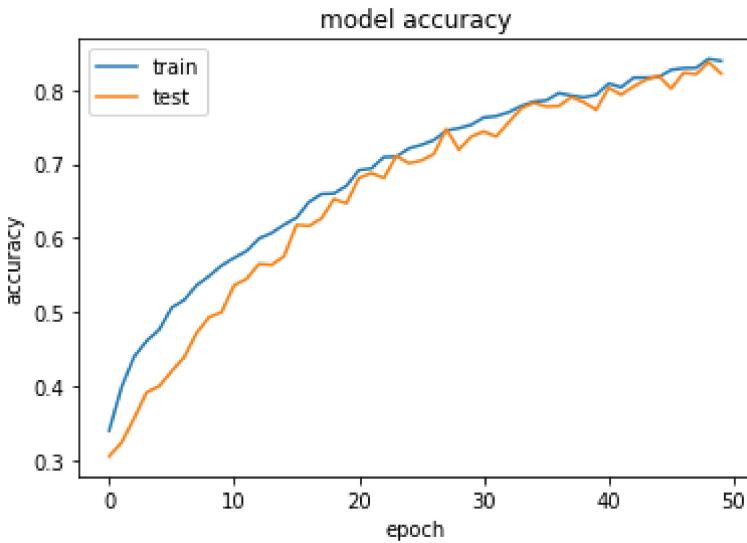
Epoch 1/50
88/88 [=====] - 24s 249ms/step - loss: 11.2371 - accuracy: 0.3399 - val_loss: 7.5964 - val_accuracy: 0.3053
Epoch 2/50
88/88 [=====] - 24s 256ms/step - loss: 6.6098 - accuracy: 0.3993 - val_loss: 6.0437 - val_accuracy: 0.3242
Epoch 3/50
88/88 [=====] - 23s 251ms/step - loss: 5.4745 - accuracy: 0.4400 - val_loss: 5.2274 - val_accuracy: 0.3570
Epoch 4/50
88/88 [=====] - 24s 258ms/step - loss: 4.8494 - accuracy: 0.4612 - val_loss: 4.7281 - val_accuracy: 0.3918
Epoch 5/50
88/88 [=====] - 23s 252ms/step - loss: 4.4004 - accuracy: 0.4763 - val_loss: 4.3724 - val_accuracy: 0.4000
Epoch 6/50
88/88 [=====] - 23s 253ms/step - loss: 4.0536 - accuracy: 0.5060 - val_loss: 4.0375 - val_accuracy: 0.4203
Epoch 7/50
88/88 [=====] - 24s 257ms/step - loss: 3.7703 - accuracy: 0.5164 - val_loss: 3.7698 - val_accuracy: 0.4391
Epoch 8/50
88/88 [=====] - 24s 262ms/step - loss: 3.5099 - accuracy: 0.5364 - val_loss: 3.5315 - val_accuracy: 0.4720
Epoch 9/50
88/88 [=====] - 24s 260ms/step - loss: 3.2988 - accuracy: 0.5488 - val_loss: 3.3169 - val_accuracy: 0.4932
Epoch 10/50
88/88 [=====] - 24s 264ms/step - loss: 3.0992 - accuracy: 0.5629 - val_loss: 3.1586 - val_accuracy: 0.5000
Epoch 11/50
88/88 [=====] - 25s 273ms/step - loss: 2.9333 - accuracy: 0.5732 - val_loss: 2.9494 - val_accuracy: 0.5362
Epoch 12/50
88/88 [=====] - 24s 266ms/step - loss: 2.7795 - accuracy: 0.5824 - val_loss: 2.8211 - val_accuracy: 0.5449
Epoch 13/50
88/88 [=====] - 24s 264ms/step - loss: 2.6375 - accuracy: 0.5994 - val_loss: 2.6807 - val_accuracy: 0.5652
Epoch 14/50
88/88 [=====] - 24s 264ms/step - loss: 2.5059 - accuracy: 0.6068 - val_loss: 2.5770 - val_accuracy: 0.5638
Epoch 15/50
88/88 [=====] - 26s 287ms/step - loss: 2.4005 - accuracy: 0.6180 - val_loss: 2.4672 - val_accuracy: 0.5754
Epoch 16/50
88/88 [=====] - 25s 272ms/step - loss: 2.2870 - accuracy: 0.6275 - val_loss: 2.3551 - val_accuracy: 0.6179
Epoch 17/50
88/88 [=====] - 25s 267ms/step - loss: 2.1841 - accuracy: 0.6488 - val_loss: 2.2724 - val_accuracy: 0.6164
Epoch 18/50
88/88 [=====] - 25s 272ms/step - loss: 2.0950 - accuracy: 0.6595 - val_loss: 2.1884 - val_accuracy: 0.6266
Epoch 19/50
88/88 [=====] - 25s 269ms/step - loss: 2.0220 - accuracy:

0.6603 - val_loss: 2.0990 - val_accuracy: 0.6527
Epoch 20/50
88/88 [=====] - 24s 266ms/step - loss: 1.9371 - accuracy: 0.6706 - val_loss: 2.0331 - val_accuracy: 0.6469
Epoch 21/50
88/88 [=====] - 24s 263ms/step - loss: 1.8611 - accuracy: 0.6918 - val_loss: 1.9496 - val_accuracy: 0.6812
Epoch 22/50
88/88 [=====] - 24s 265ms/step - loss: 1.8008 - accuracy: 0.6940 - val_loss: 1.9099 - val_accuracy: 0.6879
Epoch 23/50
88/88 [=====] - 24s 265ms/step - loss: 1.7346 - accuracy: 0.7095 - val_loss: 1.8630 - val_accuracy: 0.6812
Epoch 24/50
88/88 [=====] - 25s 272ms/step - loss: 1.6924 - accuracy: 0.7101 - val_loss: 1.7819 - val_accuracy: 0.7111
Epoch 25/50
88/88 [=====] - 24s 265ms/step - loss: 1.6303 - accuracy: 0.7212 - val_loss: 1.7659 - val_accuracy: 0.7010
Epoch 26/50
88/88 [=====] - 24s 263ms/step - loss: 1.5856 - accuracy: 0.7259 - val_loss: 1.7212 - val_accuracy: 0.7048
Epoch 27/50
88/88 [=====] - 25s 275ms/step - loss: 1.5465 - accuracy: 0.7323 - val_loss: 1.7078 - val_accuracy: 0.7135
Epoch 28/50
88/88 [=====] - 24s 264ms/step - loss: 1.5005 - accuracy: 0.7453 - val_loss: 1.6115 - val_accuracy: 0.7473
Epoch 29/50
88/88 [=====] - 25s 273ms/step - loss: 1.4571 - accuracy: 0.7484 - val_loss: 1.6149 - val_accuracy: 0.7193
Epoch 30/50
88/88 [=====] - 24s 265ms/step - loss: 1.4200 - accuracy: 0.7530 - val_loss: 1.5665 - val_accuracy: 0.7372
Epoch 31/50
88/88 [=====] - 24s 264ms/step - loss: 1.3769 - accuracy: 0.7629 - val_loss: 1.5250 - val_accuracy: 0.7440
Epoch 32/50
88/88 [=====] - 24s 266ms/step - loss: 1.3451 - accuracy: 0.7647 - val_loss: 1.5226 - val_accuracy: 0.7372
Epoch 33/50
88/88 [=====] - 24s 266ms/step - loss: 1.3165 - accuracy: 0.7701 - val_loss: 1.4729 - val_accuracy: 0.7565
Epoch 34/50
88/88 [=====] - 25s 271ms/step - loss: 1.2809 - accuracy: 0.7785 - val_loss: 1.4189 - val_accuracy: 0.7754
Epoch 35/50
88/88 [=====] - 24s 264ms/step - loss: 1.2485 - accuracy: 0.7844 - val_loss: 1.3875 - val_accuracy: 0.7826
Epoch 36/50
88/88 [=====] - 25s 271ms/step - loss: 1.2225 - accuracy: 0.7860 - val_loss: 1.3829 - val_accuracy: 0.7778
Epoch 37/50
88/88 [=====] - 24s 265ms/step - loss: 1.1982 - accuracy: 0.7957 - val_loss: 1.3571 - val_accuracy: 0.7783
Epoch 38/50

```
88/88 [=====] - 24s 264ms/step - loss: 1.1767 - accuracy: 0.7926 - val_loss: 1.3518 - val_accuracy: 0.7903
Epoch 39/50
88/88 [=====] - 24s 265ms/step - loss: 1.1682 - accuracy: 0.7901 - val_loss: 1.3294 - val_accuracy: 0.7836
Epoch 40/50
88/88 [=====] - 24s 267ms/step - loss: 1.1441 - accuracy: 0.7934 - val_loss: 1.3349 - val_accuracy: 0.7734
Epoch 41/50
88/88 [=====] - 24s 265ms/step - loss: 1.1087 - accuracy: 0.8088 - val_loss: 1.2513 - val_accuracy: 0.8029
Epoch 42/50
88/88 [=====] - 24s 265ms/step - loss: 1.1017 - accuracy: 0.8037 - val_loss: 1.2952 - val_accuracy: 0.7937
Epoch 43/50
88/88 [=====] - 25s 270ms/step - loss: 1.0794 - accuracy: 0.8166 - val_loss: 1.2514 - val_accuracy: 0.8048
Epoch 44/50
88/88 [=====] - 24s 265ms/step - loss: 1.0692 - accuracy: 0.8167 - val_loss: 1.2150 - val_accuracy: 0.8140
Epoch 45/50
88/88 [=====] - 24s 267ms/step - loss: 1.0485 - accuracy: 0.8174 - val_loss: 1.2058 - val_accuracy: 0.8193
Epoch 46/50
88/88 [=====] - 25s 272ms/step - loss: 1.0185 - accuracy: 0.8272 - val_loss: 1.2233 - val_accuracy: 0.8019
Epoch 47/50
88/88 [=====] - 24s 263ms/step - loss: 1.0101 - accuracy: 0.8295 - val_loss: 1.1638 - val_accuracy: 0.8232
Epoch 48/50
88/88 [=====] - 25s 272ms/step - loss: 0.9947 - accuracy: 0.8298 - val_loss: 1.1621 - val_accuracy: 0.8213
Epoch 49/50
88/88 [=====] - 25s 269ms/step - loss: 0.9631 - accuracy: 0.8421 - val_loss: 1.1207 - val_accuracy: 0.8377
Epoch 50/50
88/88 [=====] - 24s 262ms/step - loss: 0.9620 - accuracy: 0.8393 - val_loss: 1.1797 - val_accuracy: 0.8222
```

Evaluation

```
In [ ]: plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'test'], loc='upper left')
plt.show()
```



```
In [ ]: print("Training Accuracy: ", history.history['accuracy'][-1]*100, "%")
```

Training Accuracy: 83.93176198005676 %

```
In [ ]: print("Testing Accuracy: ", history.history['val_accuracy'][-1]*100, "%")
```

Testing Accuracy: 82.2222328186035 %

```
In [ ]: model.save("VGGmodel50")
```

WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op, _jit_compiled_convolution_op while saving (showing 5 of 13). These functions will not be directly callable after loading.

```
In [ ]: model = keras.models.load_model('/content/drive/My Drive/VGGModel50/model.h5')
```

```
In [ ]: def test_model(model):
    prefix = "/content/drive/MyDrive/diabetic_retinopathy_detection/data/test"
    classes = os.listdir(prefix)
    choices = []

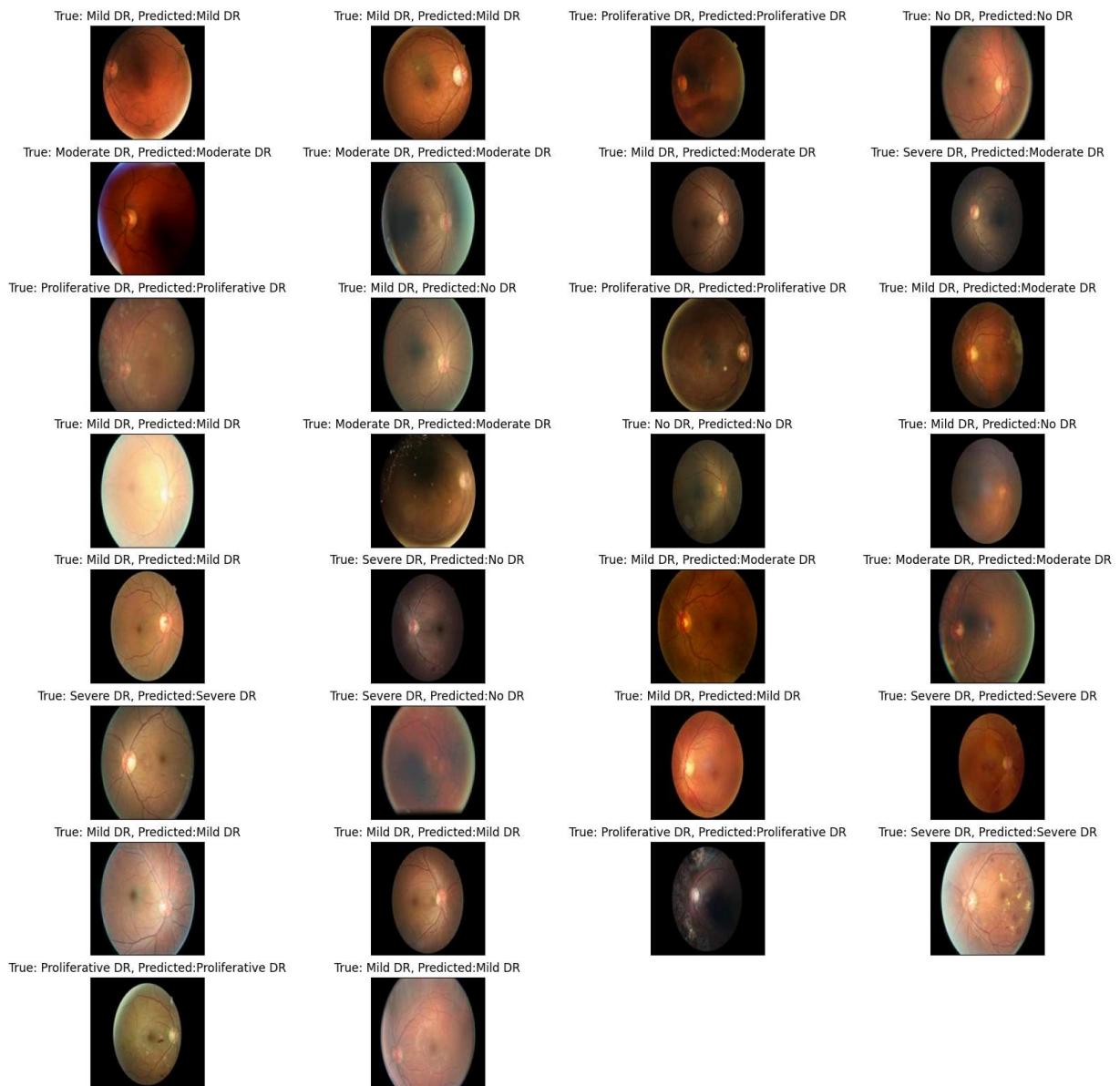
    for i in range(6):
        temp = {}
        for j in range(5):
            ch = random.choice(classes)
            li = os.listdir(prefix+"/"+ch)
            file_ = prefix+"/"+ch+"/"+random.choice(li)
            temp[file_] = ch
        choices.append(temp)

    plt.figure(figsize=(20, 20))
    n = 4
    im = 8
    ct = 1
    for row in choices:
        for i in row:
            ax = plt.subplot(im, n, ct)
            ct = ct + 1
```

```
image = cv2.imread(i)
image = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)
plt.imshow(image)
image = np.expand_dims(image, 0)
ax.get_xaxis().set_visible(False)
ax.get_yaxis().set_visible(False)
ax.set_title("True: {}, Predicted:{}".format(row[i], train_ds.class_names[i]))
plt.show()
```

In []: test_model(model)

```
1/1 [=====] - 0s 464ms/step
1/1 [=====] - 0s 177ms/step
1/1 [=====] - 0s 179ms/step
1/1 [=====] - 0s 292ms/step
1/1 [=====] - 0s 312ms/step
1/1 [=====] - 0s 310ms/step
1/1 [=====] - 0s 288ms/step
1/1 [=====] - 0s 177ms/step
1/1 [=====] - 0s 334ms/step
1/1 [=====] - 0s 191ms/step
1/1 [=====] - 0s 174ms/step
1/1 [=====] - 0s 180ms/step
1/1 [=====] - 0s 181ms/step
1/1 [=====] - 0s 195ms/step
1/1 [=====] - 0s 176ms/step
1/1 [=====] - 0s 191ms/step
1/1 [=====] - 0s 177ms/step
1/1 [=====] - 0s 173ms/step
1/1 [=====] - 0s 175ms/step
1/1 [=====] - 0s 174ms/step
1/1 [=====] - 0s 175ms/step
1/1 [=====] - 0s 177ms/step
1/1 [=====] - 0s 173ms/step
1/1 [=====] - 0s 175ms/step
1/1 [=====] - 0s 321ms/step
1/1 [=====] - 0s 310ms/step
1/1 [=====] - 0s 309ms/step
1/1 [=====] - 0s 292ms/step
1/1 [=====] - 0s 310ms/step
1/1 [=====] - 0s 182ms/step
```



In []: