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

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", force_remount=True).
```

In [ ]:
```
#some extra libaries
```

In [ ]:
```
from keras.layers import Dense, Input, Conv2D, LSTM, MaxPool2D, UpSampling2D
from sklearn.model_selection import train_test_split
```

In [ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import cv2
import tensorflow as tf
from tensorflow import keras
from pathlib import Path
import PIL
import os
```

In [ ]:
```
#load the dataset andb set the path
```

In [ ]:
```
folder_path ="/content/drive/My Drive/project/dataset"
```

In [ ]:
```
# import the neccesary libaries and set the path
```

In [ ]:
```
from pathlib import Path
import pandas as pd
from tqdm import tqdm

folder_path = "/content/drive/My Drive/project/dataset"
glaucoma = Path(folder_path + '/glaucoma')
cataract = Path(folder_path + '/cataract')
normal = Path(folder_path + '/normal')
diabetic_retinopathy = Path(folder_path + '/diabetic_retinopathy')

disease_type = [glaucoma, cataract, normal, diabetic_retinopathy]
df = pd.DataFrame()
```

In [ ]:
```
for types in disease_type:
    if types.exists():  # Check if the directory exists
        for imagepath in tqdm(list(types.iterdir()), desc=str(types)):
            df = pd.concat([df, pd.DataFrame({
                'image': [str(imagepath)],
                'disease_type': [disease_type.index(types)]
            })], ignore_index=True)
```

```
/content/drive/My Drive/project/dataset/glaucoma: 100%|██████████| 1007/1007 [00:00<00:00, 1966.90it/s]
/content/drive/My Drive/project/dataset/cataract: 100%|██████████| 1038/1038 [00:00<00:00, 1738.06it/s]
/content/drive/My Drive/project/dataset/normal: 100%|██████████| 1075/1075 [00:00<00:00, 1758.81it/s]
/content/drive/My Drive/project/dataset/diabetic_retinopathy: 100%|██████████| 1098/1098 [00:00<00:00, 1747.03it/s]
```

In [ ]:
```
df
```

Out[ ]:

| | image | disease_type |
|---|---|---|

| | | |
|---|---|---|
| **0** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **1** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **2** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **3** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **4** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **...** | ... | ... |
| **4213** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4214** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4215** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4216** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4217** | /content/drive/My Drive/project/dataset/diabet... | 3 |

4218 rows × 2 columns

In [ ]:
```
#inspect the data
```

In [ ]:
```
df.head()
```

Out[ ]:

| | image | disease_type |
|---|---|---|
| **0** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **1** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **2** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **3** | /content/drive/My Drive/project/dataset/glauco... | 0 |
| **4** | /content/drive/My Drive/project/dataset/glauco... | 0 |

In [ ]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 4218 entries, 0 to 4217
Data columns (total 2 columns):
 #   Column        Non-Null Count  Dtype 
---  ------        --------------  ----- 
 0   image         4218 non-null   object
 1   disease_type  4218 non-null   int64 
dtypes: int64(1), object(1)
memory usage: 66.0+ KB
```

In [ ]:
```
df.describe()
```

Out[ ]:

| | disease_type |
|---|---|
| **count** | 4218.000000 |
| **mean** | 1.536747 |
| **std** | 1.116713 |
| **min** | 0.000000 |
| **25%** | 1.000000 |
| **50%** | 2.000000 |
| **75%** | 3.000000 |

| | |
|---|---|
| **max** | 3.000000 |

In [ ]:
```
df.shape
```

Out[ ]:
```
(4218, 2)
```

In [ ]:
```
df.columns
```

Out[ ]:
```
Index(['image', 'disease_type'], dtype='object')
```

In [ ]:
```
df.count() # number of rows
```

Out[ ]:

| | 0 |
|---|---|
| **image** | 4218 |
| **disease_type** | 4218 |

**dtype:** int64

In [ ]:
```
df.disease_type.value_counts()
```

Out[ ]:

| **disease_type** | **count** |
|---|---|
| **3** | 1098 |
| **2** | 1075 |
| **1** | 1038 |
| **0** | 1007 |

**dtype:** int64

In [ ]:
```
# check if null  values present are not.
```

In [ ]:
```
df.isnull().sum()
```

Out[ ]:

| | 0 |
|---|---|
| **image** | 0 |
| **disease_type** | 0 |

**dtype:** int64

In [ ]:
```
#viusilize images in dataset
```

In [ ]:
```
from tensorflow.keras.preprocessing.image import load_img, img_to_array
```

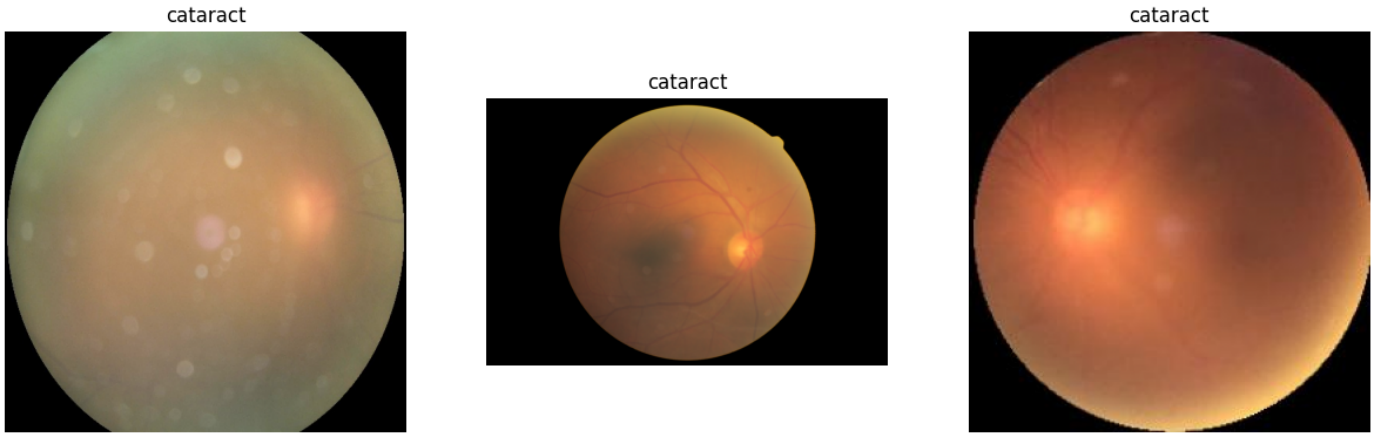
In [ ]:
```
def plot_image(n, num_samples=3):
    diseases_lables = ['glaucoma','cataract', ' normal ',  ' diabetic_retinopathy']
    images = df[df['disease_type'] == n].sample(num_samples)['image']
    plt.figure(figsize=(15,6))

    for i, path in enumerate(images, 1):
      img= (plt.imread(path)- path.imread(path).min())/plt.imread(path).max()
```

```
        plt.subplot(3,3,i)
        plt.imshow(img)
        plt.axis('off')
        plt.title(diseases_lables[n])
        plt.show()
```

In [ ]:
```
import seaborn as sns # visualization
import cv2
import tensorflow as tf
from tensorflow import keras
from pathlib import Path
import PIL
import os
```

In [ ]:
```
import matplotlib.pyplot as plt

def plot_image(n, num_samples=3):
    disease_labels = ['glaucoma', 'cataract', 'normal', 'diabetic_retinopathy']
    images = df[df['disease_type'] == n].sample(num_samples)['image']
    plt.figure(figsize=(15, 6))

    for i, path in enumerate(images, 1):
        # Load the image using plt.imread
        img = plt.imread(path)

        # Normalize the image
        img = (img - img.min()) / img.max()

        # Plot the image
        plt.subplot(1, num_samples, i)
        plt.imshow(img)
        plt.axis('off')
        plt.title(disease_labels[n])

    plt.show()
```

In [ ]:
```
plot_image(n=1, num_samples=3)
```




In [ ]:
```
plot_image(3)
```


In [ ]:
```
df.tail()
```

Out[ ]:

| | image | disease_type |
|---|---|---|
| **4213** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4214** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4215** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4216** | /content/drive/My Drive/project/dataset/diabet... | 3 |
| **4217** | /content/drive/My Drive/project/dataset/diabet... | 3 |

In [ ]:
```
#show some samples:
```

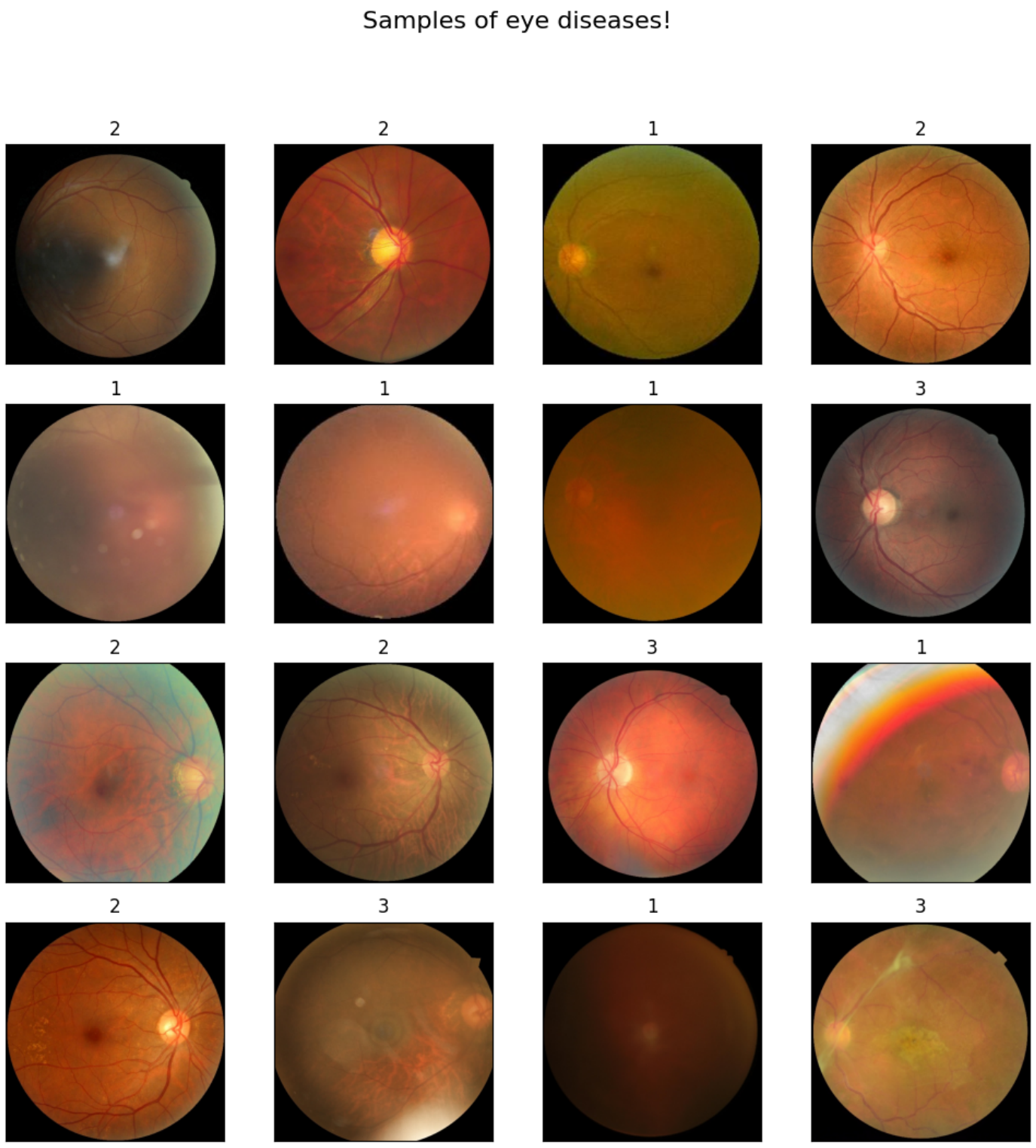
In [ ]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import zipfile
import os
import cv2
import glob
import albumentations as A
from pathlib import Path
import tensorflow as tf
from sklearn.model_selection import train_test_split
```

In [ ]:
```
from tensorflow.keras.applications import EfficientNetB3,InceptionResNetV2
from sklearn.metrics import confusion_matrix, classification_report
from tensorflow.keras import layers,regularizers
from tensorflow.keras import callbacks

from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

In [ ]:
```
def show_image_sample(df):
    file_column = 'image'  # Column with file paths
    label_column = 'disease_type'  # Column with labels

    random_data = df.sample(n=16)
    fig, axes = plt.subplots(nrows=4, ncols=4, figsize=(10, 10),
                             subplot_kw={'xticks': [], 'yticks': []})
    plt.suptitle('Samples of eye diseases!', y=1.05, fontsize=16)

    for i, ax in enumerate(axes.flat):
        ax.imshow(plt.imread(random_data.iloc[i][file_column]))
        ax.set_title(random_data.iloc[i][label_column])
```

```
    plt.tight_layout()
    plt.show()
```

In [ ]:
```
show_image_sample(df)
```




In [ ]:
```
## check for duplicates
df.duplicated().sum()
```

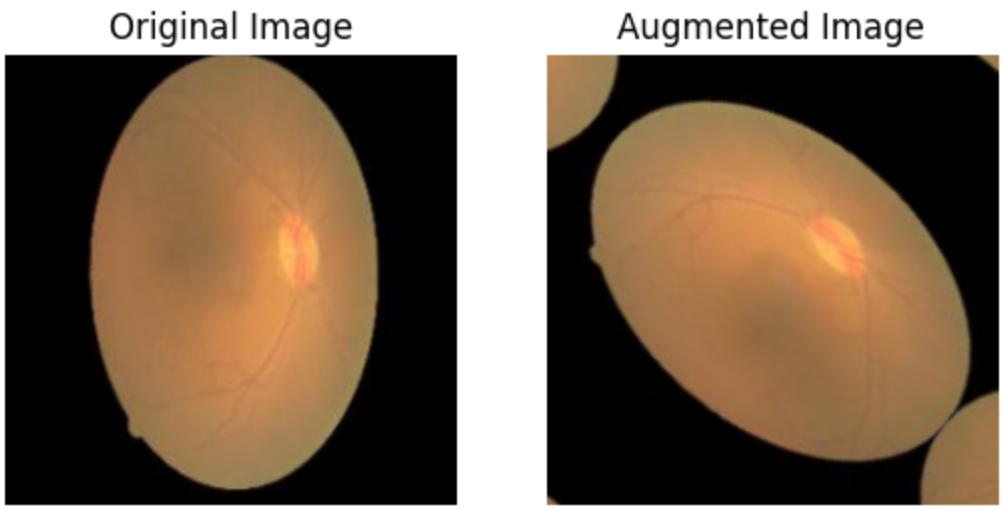
Out[ ]:
```
0
```

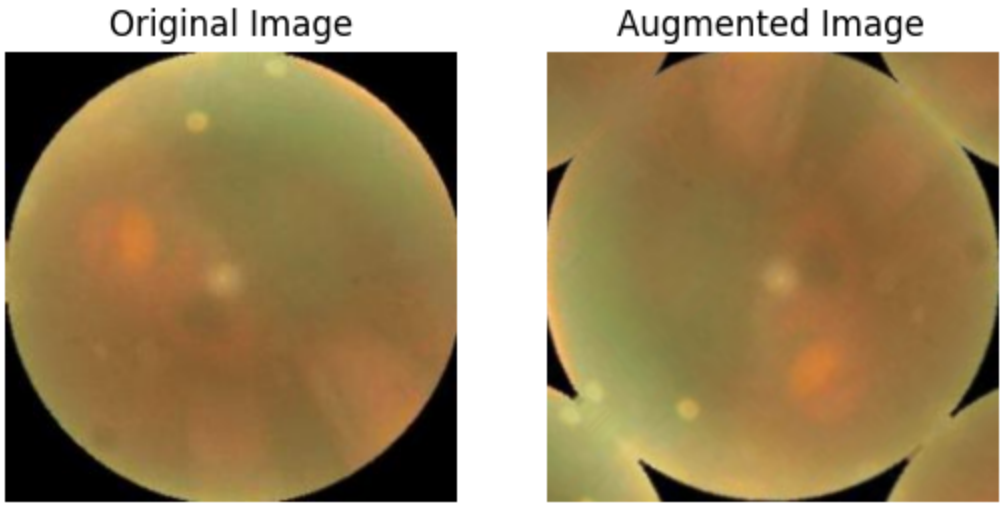
In [ ]:
```
# data agumentation
```

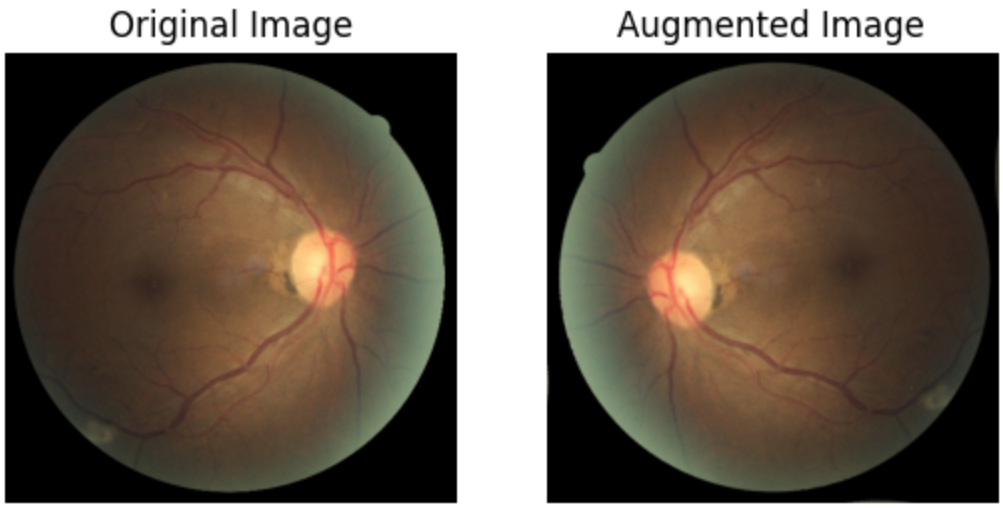
In [ ]:
```
import albumentations as A
import cv2
import matplotlib.pyplot as plt
```

```python
def augment_image(image):
    aug = A.Compose([
        A.Flip(),
        A.Rotate(limit=75, always_apply=True),
    ])
    augmented_image = aug(image=image)['image']
    return augmented_image

def show_original_augment_image(df):
    file_column = 'image'

    random_data = df.sample(n=3)

    for i in range(len(random_data)):
        # Read the original image
        image = cv2.imread(random_data.iloc[i][file_column])


        augmented_image = augment_image(image)


        plt.subplot(1, 2, 1)
        plt.imshow(cv2.cvtColor(image, cv2.COLOR_BGR2RGB))
        plt.axis('off')
        plt.title("Original Image")

        plt.subplot(1, 2, 2)
        plt.imshow(cv2.cvtColor(augmented_image, cv2.COLOR_BGR2RGB))
        plt.axis('off')
        plt.title("Augmented Image")

        plt.show()
```

In [ ]:
```python
show_original_augment_image(df)
```






In [ ]:
```
df['disease_type']=df['disease_type'].map({0: 'glaucoma', 1:'cataract' , 2: 'normal', 3:
```

In [ ]:
```
df.disease_type.value_counts()
```

Out[ ]:

| disease_type | count |
|---|---|
| **diabetic_retinopathy** | 1098 |
| **normal** | 1075 |
| **cataract** | 1038 |
| **glaucoma** | 1007 |

**dtype:** int64

In [ ]:
```
# set target and feature values from dataset
```

In [ ]:
```
#Feature selection
```

In [ ]:
```
from sklearn.feature_selection import RFE, RFECV
from sklearn.linear_model import LinearRegression
from sklearn.preprocessing import StandardScaler
```

In [282…
```
#train-test data
```

In [ ]:
```
from sklearn.model_selection import train_test_split

# Split your data into features (X) and labels (y)
x = df['image']  # 'image' contains image data
y = df['disease_type']  # 'disease_type' contains labels

# Split the data into training and testing sets
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=42
```

In [ ]:
```
x
```

Out[ ]:

| | image |
|---|---|
| **0** | /content/drive/My Drive/project/dataset/glauco... |
| **1** | /content/drive/My Drive/project/dataset/glauco... |
| **2** | /content/drive/My Drive/project/dataset/glauco... |
| **3** | /content/drive/My Drive/project/dataset/glauco... |
| **4** | /content/drive/My Drive/project/dataset/glauco... |
| **...** | ... |
| **4213** | /content/drive/My Drive/project/dataset/diabet... |
| **4214** | /content/drive/My Drive/project/dataset/diabet... |
| **4215** | /content/drive/My Drive/project/dataset/diabet... |
| **4216** | /content/drive/My Drive/project/dataset/diabet... |
| **4217** | /content/drive/My Drive/project/dataset/diabet... |

4218 rows × 1 columns

**dtype:** object

In [ ]:
```
y
```

Out[ ]:

| | disease_type |
|---|---|
| **0** | glaucoma |
| **1** | glaucoma |
| **2** | glaucoma |
| **3** | glaucoma |
| **4** | glaucoma |
| **...** | ... |
| **4213** | diabetic_retinopathy |
| **4214** | diabetic_retinopathy |
| **4215** | diabetic_retinopathy |
| **4216** | diabetic_retinopathy |
| **4217** | diabetic_retinopathy |

4218 rows × 1 columns

**dtype:** object

In [ ]:
```
#data augmentation using the ImageDataGenerator
```

In [ ]:
```
from tensorflow.keras.applications.mobilenet_v2 import preprocess_input
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

In [ ]:
```
datagen = ImageDataGenerator(preprocessing_function=preprocess_input,validation_split=0.
```

In [ ]:
```
datagen
```

Out[ ]:
```
<keras.src.legacy.preprocessing.image.ImageDataGenerator at 0x7ecdc7160940>
```

In [ ]:
```
#data generators for tarining
```

In [ ]:
```
# Convert the 'disease_type' column to string
df['disease_type'] = df['disease_type'].astype(str)


train_data = datagen.flow_from_dataframe(dataframe=df,
                                         x_col='image',
                                         y_col='disease_type',
                                         target_size=(224, 224),
                                         class_mode='categorical',
                                         batch_size=32,
                                         shuffle=True,
                                         subset='training')
```

```
Found 3375 validated image filenames belonging to 4 classes.
```

In [ ]:
```
# Data generators for validation
```

In [ ]:
```
df['disease_type'] = df['disease_type'].astype(str)

valid_data = datagen.flow_from_dataframe(dataframe=df,
                                         x_col ='image',
                                         y_col = 'disease_type',
                                         target_size=(224,224),
                                         class_mode = 'categorical',
                                         batch_size = 32,
                                         shuffle = True,
                                         subset = 'validation')
```

```
Found 843 validated image filenames belonging to 4 classes.
```

In [ ]:
```
#BUILDING THE  MODEL
```

In [ ]:
```
from keras.layers import Dense, Conv2D, MaxPool2D, Flatten, BatchNormalization, Dropout,
from keras.models import Sequential
```

In [301…
```
# labeling this
```

In [ ]:
```
labels= [key for key in train_data.class_indices ]
num_classes= len(disease_type)
```

In [293…
```
# 1st approach
```

In [283…
```
from tensorflow.keras.applications.vgg19 import VGG19
image_size=224
vgg = VGG19(weights="imagenet",include_top = False,input_shape=(image_size,image_size,3)
```

In [292…
```
# 2nd approach
```

In [284…
```
from tensorflow.keras.applications import ResNet50

resnet = ResNet50(weights='imagenet', include_top=False, input_shape=(image_size, image_

model = Sequential()
model.add(resnet)
model.add(Flatten())
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/resne
t/resnet50_weights_tf_dim_ordering_tf_kernels_notop.h5
94765736/94765736 □□□□□□□□□□□□□□□□□□□□ 3s 0us/step
```

In [294…
```
model.summary()
```

**Model: "sequential_12"**

| Layer (type) | Output Shape | Para |
|---|---|---|
| conv2d_100 (Conv2D) | (None, 222, 222, 32) | |
| max_pooling2d_10 (MaxPooling2D) | (None, 111, 111, 32) | |
| batch_normalization_100 (BatchNormalization) | (None, 111, 111, 32) | |
| conv2d_101 (Conv2D) | (None, 109, 109, 64) | 18, |
| max_pooling2d_11 (MaxPooling2D) | (None, 54, 54, 64) | |
| batch_normalization_101 (BatchNormalization) | (None, 54, 54, 64) | |
| flatten_12 (Flatten) | (None, 186624) | |
| dense_30 (Dense) | (None, 256) | 47,776, |
| dropout_3 (Dropout) | (None, 256) | |
| dense_31 (Dense) | (None, 4) | 1, |

**Total params:** 47,796,804 (182.33 MB)

**Trainable params:** 47,796,612 (182.33 MB)

**Non-trainable params:** 192 (768.00 B)

In [291…
```
# 3rd model tecnique
```

In [302…
```
from tensorflow.keras.applications import InceptionV3

inception = InceptionV3(weights='imagenet', include_top=False, input_shape=(image_size,

model = Sequential()
model.add(inception)
model.add(Flatten())
model.add(Dense(512, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
```

In [290…
```
# 4th approach
```

In [286…
```
from tensorflow.keras.applications import MobileNetV2
```

```
mobilenet = MobileNetV2(weights='imagenet', include_top=False, input_shape=(image_size,

model = Sequential()
model.add(mobilenet)
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/mobil
enet_v2/mobilenet_v2_weights_tf_dim_ordering_tf_kernels_1.0_224_no_top.h5
9406464/9406464 ▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯▯ 1s 0us/step
```

In [289…
```
# 5th approach
```

In [288…
```
from tensorflow.keras.layers import Conv2D, MaxPooling2D, BatchNormalization

model = Sequential()

model.add(Conv2D(32, (3, 3), activation='relu', input_shape=(image_size, image_size, 3))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())

model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(BatchNormalization())

model.add(Flatten())
model.add(Dense(256, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(num_classes, activation='softmax'))
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/convolutional/base_conv.py:107:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Se
quential models, prefer using an `Input(shape)` object as the first layer in the model i
nstead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [ ]:
```
```

In [287…
```
for layer in vgg.layers:
    layer.trainable = False
```

In [ ]:
```
# model summarization
```

In [ ]:
```
from tensorflow.keras import Sequential
from tensorflow.keras.layers import Flatten, Dense


model= Sequential()
model.add(vgg)
model.add(Flatten())

model.add(Dense(256, activation='relu'))
model.add(tf.keras.layers.BatchNormalization())

model.add(Dense(256,activation= 'relu'))
model.add(tf.keras.layers.BatchNormalization())

model.add(Dense(4,activation='softmax'))
```

In [ ]:
```
model = tf.keras.Sequential([
    # Input layer, assuming input images of size 224x224x3
```

```
    tf.keras.layers.Conv2D(32, (3, 3), activation='relu', input_shape=(224, 224, 3)),
    tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),

    # Additional layers
    tf.keras.layers.Conv2D(64, (3, 3), activation='relu'),
    tf.keras.layers.MaxPooling2D(pool_size=(2, 2)),

    tf.keras.layers.Flatten(),
    tf.keras.layers.Dense(128, activation='relu'),
    tf.keras.layers.Dense(4, activation='softmax')
])
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/convolutional/base_conv.py:107:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Se
quential models, prefer using an `Input(shape)` object as the first layer in the model i
nstead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [ ]:
```
# Compile the model
model.compile(optimizer='adam',
              loss=tf.keras.losses.CategoricalCrossentropy(),
              metrics=['accuracy'])
```

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

**Model: "sequential_5"**

| Layer (type) | Output Shape | Para |
|---|---|---|
| conv2d_2 (Conv2D) | (None, 222, 222, 32) | |
| max_pooling2d_2 (MaxPooling2D) | (None, 111, 111, 32) | |
| conv2d_3 (Conv2D) | (None, 109, 109, 64) | 18, |
| max_pooling2d_3 (MaxPooling2D) | (None, 54, 54, 64) | |
| flatten_5 (Flatten) | (None, 186624) | |
| dense_14 (Dense) | (None, 128) | 23,888, |
| dense_15 (Dense) | (None, 4) | |

**Total params:** 23,907,908 (91.20 MB)

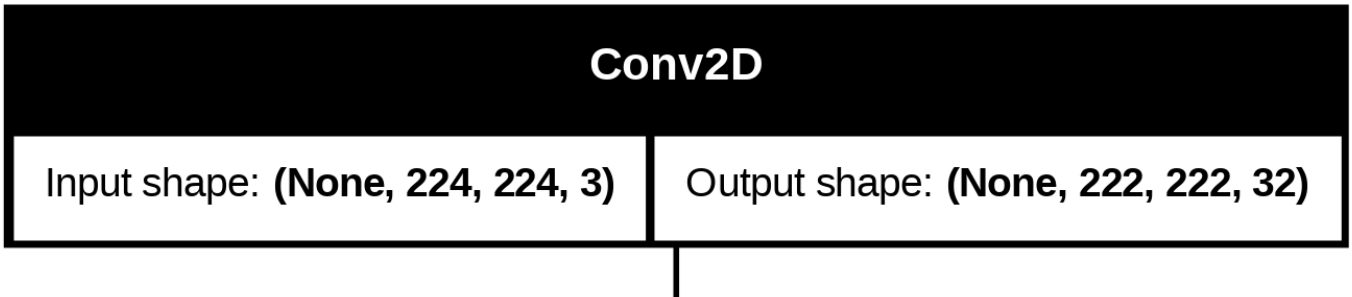
**Trainable params:** 23,907,908 (91.20 MB)

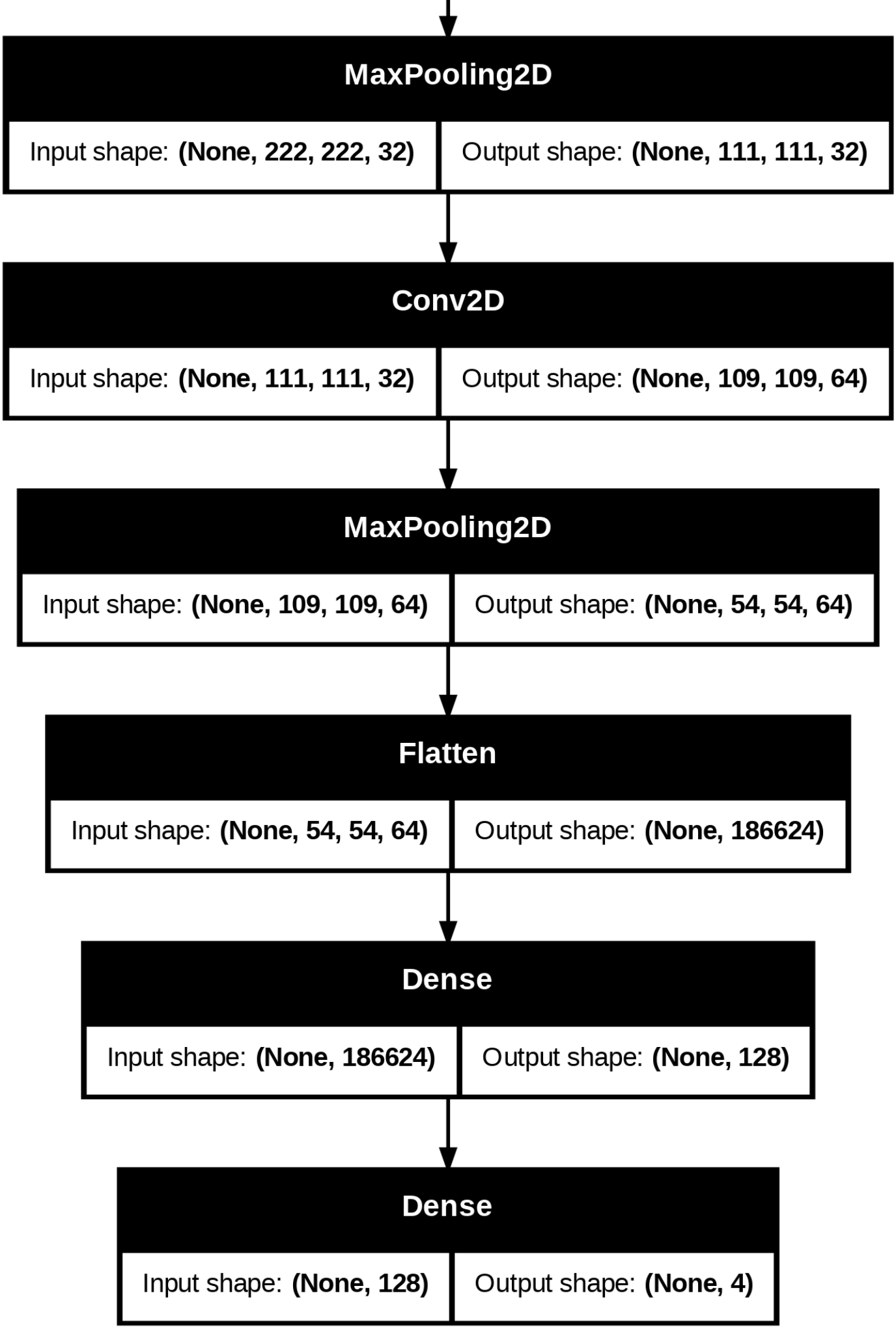
**Non-trainable params:** 0 (0.00 B)

In [ ]:
```
# data ploting using keras modeling techniques
```

In [ ]:
```
tf.keras.utils.plot_model(model,
                          to_file="model.png",
                          show_shapes=True,
                          expand_nested=True)
```

Out[ ]:




MaxPooling2D
Input shape: (None, 222, 222, 32)
Output shape: (None, 111, 111, 32)
Conv2D
Input shape: (None, 111, 111, 32)
Output shape: (None, 109, 109, 64)
MaxPooling2D
Input shape: (None, 109, 109, 64)
Output shape: (None, 54, 54, 64)
Flatten
Input shape: (None, 54, 54, 64)
Output shape: (None, 186624)
Dense
Input shape: (None, 186624)
Output shape: (None, 128)
Dense
Input shape: (None, 128)
Output shape: (None, 4)

In [ ]:
```
# check the checkpoint technique in the model
```

In [ ]:
```
from tensorflow.keras.callbacks import ModelCheckpoint, EarlyStopping

# ModelCheckpoint with updated file extension
checkpoint = ModelCheckpoint("vgg19.keras",  # Change .h5 to .keras
                             monitor="val_acc",
                             verbose=1,
                             save_best_only=True,
                             save_weights_only=False,
                             save_freq='epoch')

# EarlyStopping callback
earlystop = EarlyStopping(monitor="val_acc",
                          patience=5,
                          verbose=1)
```

In [260…
```
his = model.fit(
    train_data,       # Training data
    batch_size=32,    # Batch size for training
    epochs=20,        # Number of training epochs
    validation_data=valid_data,  # Validation data
    verbose=1,        # Verbosity level for training logs
    callbacks=[checkpoint, earlystop]  # Callback functions
)
```

```
Epoch 1/20
/usr/local/lib/python3.10/dist-packages/keras/src/trainers/data_adapters/py_dataset_adapter.py:121: UserWarning: Your `PyDataset` class should call `super().__init__(**kwargs)` in its constructor. `**kwargs` can include `workers`, `use_multiprocessing`, `max_queue_size`. Do not pass these arguments to `fit()`, as they will be ignored.
  self._warn_if_super_not_called()
106/106 ━━━━━━━━━━━━━━━━━━━━ 0s 3s/step - accuracy: 0.6180 - loss: 2.6787
/usr/local/lib/python3.10/dist-packages/keras/src/callbacks/model_checkpoint.py:206: UserWarning: Can save best model only with val_acc available, skipping.
  self._save_model(epoch=epoch, batch=None, logs=logs)
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-260-a6bbb6373613> in <cell line: 1>()
----> 1 his = model.fit(
      2     train_data,       # Training data
      3     batch_size=32,    # Batch size for training
      4     epochs=20,        # Number of training epochs
      5     validation_data=valid_data,  # Validation data

/usr/local/lib/python3.10/dist-packages/keras/src/utils/traceback_utils.py in error_handler(*args, **kwargs)
    120             # To get the full stack trace, call:
    121             # `keras.config.disable_traceback_filtering()`
--> 122             raise e.with_traceback(filtered_tb) from None
    123         finally:
    124             del filtered_tb

/usr/local/lib/python3.10/dist-packages/keras/src/callbacks/early_stopping.py in _set_monitor_op(self)
    127                                 self.monitor_op = ops.less
    128         if self.monitor_op is None:
--> 129             raise ValueError(
    130                 f"EarlyStopping callback received monitor={self.monitor} "
    131                 "but Keras isn't able to automatically determine whether "

ValueError: EarlyStopping callback received monitor=val_acc but Keras isn't able to automatically determine whether that metric should be maximized or minimized. Pass `mode='ma
```

```
x'` in order to do early stopping based on the highest metric value, or pass `mode='mi
n'` in order to use the lowest value.
```

In [ ]:
```
his = model.fit(
    train_data,
    validation_data=valid_data,
    epochs = 10,
)
```

In [ ]:
```
# check the model accuracy
```

In [262…
```
loss, accuracy = model.evaluate(valid_data)
print("Loss:", loss)
print("Accuracy:", accuracy)
```

```
27/27 ━━━━━━━━━━━━━━━━━━━━ 70s 3s/step - accuracy: 0.0322 - loss: 2.4699
Loss: 2.48268461227417
Accuracy: 0.035587187856435776
```

In [ ]:
```
#model evalution
```

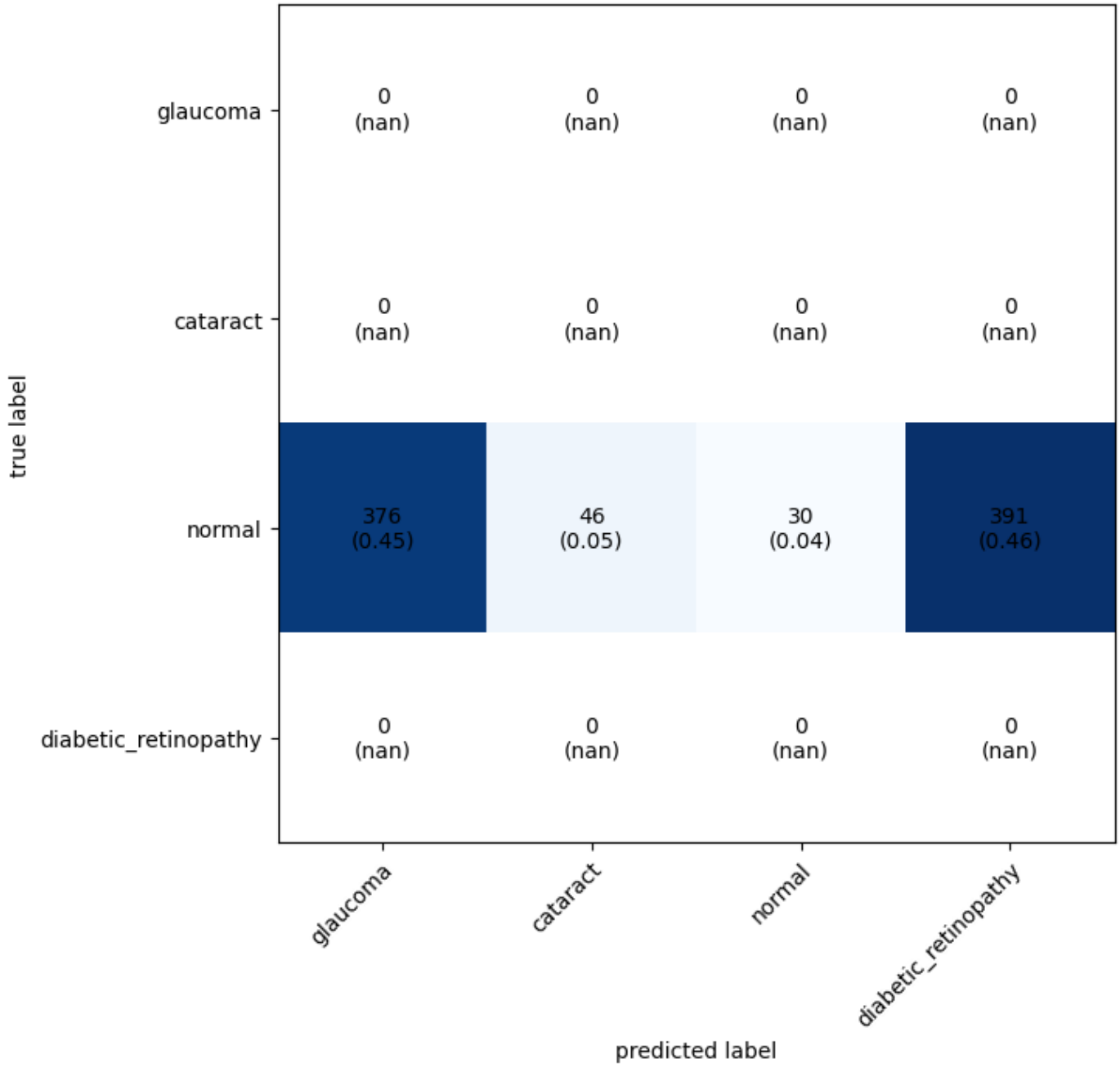
In [263…
```
y_test = valid_data.classes
y_pred = model.predict(valid_data)
y_pred = np.argmax(y_pred,axis=1)
```

```
27/27 ━━━━━━━━━━━━━━━━━━━━ 35s 1s/step
```

In [ ]:
```
# model  evalution and validation in the from of visuilization of the model
```

In [264…
```
from mlxtend.plotting import plot_confusion_matrix
cm = confusion_matrix(y_test,y_pred)
plot_confusion_matrix(conf_mat = cm,figsize=(8,7),class_names = ["glaucoma", "cataract",
                      show_normed = True);
plt.savefig("Predected & True Label.png")
```

```
/usr/local/lib/python3.10/dist-packages/mlxtend/plotting/plot_confusion_matrix.py:102: R
untimeWarning: invalid value encountered in divide
  normed_conf_mat = conf_mat.astype("float") / total_samples
```




In [ ]:
```
# check classification_report of the model
```

In [265…
```
print(classification_report(y_test,y_pred,target_names = labels))
```

```
                    precision    recall  f1-score   support

          cataract       0.00      0.00      0.00         0
diabetic_retinopathy       0.00      0.00      0.00         0
          glaucoma       1.00      0.04      0.07       843
            normal       0.00      0.00      0.00         0

          accuracy                           0.04       843
         macro avg       0.25      0.01      0.02       843
      weighted avg       1.00      0.04      0.07       843
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: Undefin
edMetricWarning: Recall and F-score are ill-defined and being set to 0.0 in labels with
no true samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: Undefin
edMetricWarning: Recall and F-score are ill-defined and being set to 0.0 in labels with
no true samples. Use `zero_division` parameter to control this behavior.
```

```
  _warn_prf(average, modifier, msg_start, len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1471: Undefin
edMetricWarning: Recall and F-score are ill-defined and being set to 0.0 in labels with
no true samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, msg_start, len(result))
```

In [266…

```
import seaborn as sns
import matplotlib.pyplot as plt

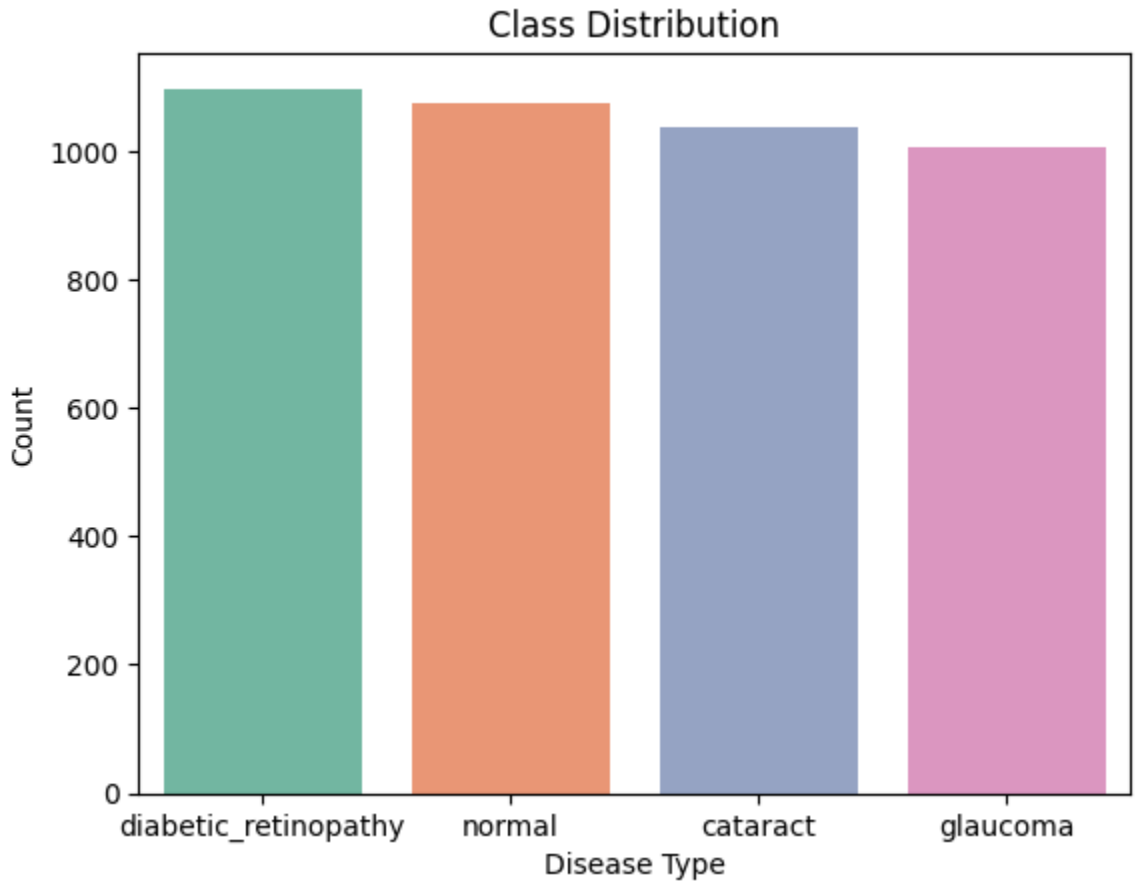
# Assuming df is your DataFrame containing the 'image' and 'disease_type' columns
sns.barplot(x=df['disease_type'].value_counts().index, y=df['disease_type'].value_counts

plt.title("Class Distribution")
plt.xlabel("Disease Type")
plt.ylabel("Count")
plt.show()
```

```
<ipython-input-266-2f26dee22fd1>:5: FutureWarning:

Passing `palette` without assigning `hue` is deprecated and will be removed in v0.14.0.
Assign the `x` variable to `hue` and set `legend=False` for the same effect.

  sns.barplot(x=df['disease_type'].value_counts().index, y=df['disease_type'].value_coun
ts().values, palette="Set2")
```




In [ ]:

```
# check training of the model using another method
```

In [267…

```
from sklearn import svm
from sklearn.model_selection import KFold
from sklearn.model_selection import cross_val_score
from sklearn.metrics import confusion_matrix
```

In [268…

```
# fine tuning with grid search
from sklearn.model_selection import GridSearchCV

g=np.arange(1e-4,1e-1,0.0001)
```

```
g=g.tolist()
parameters = {"kernel": ("sigmoid", "rbf", "poly", "linear"),
              "C": [1, 10, 0.1],
             "gamma": g}
method = svm.SVC()
grid_search = GridSearchCV(method, parameters)
grid_search.fit(x_train, y_train)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-268-272f594123a1> in <cell line: 11>()
      9 method = svm.SVC()
     10 grid_search = GridSearchCV(method, parameters)
---> 11 grid_search.fit(x_train, y_train)

/usr/local/lib/python3.10/dist-packages/sklearn/base.py in wrapper(estimator, *args, **k
wargs)
   1150                 )
   1151             ):
-> 1152                 return fit_method(estimator, *args, **kwargs)
   1153
   1154         return wrapper

/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.py in fit(self,
 X, y, groups, **fit_params)
    896                 return results
    897
--> 898             self._run_search(evaluate_candidates)
    899
    900             # multimetric is determined here because in the case of a callable

/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.py in _run_searc
h(self, evaluate_candidates)
   1420     def _run_search(self, evaluate_candidates):
   1421         """Search all candidates in param_grid"""
-> 1422         evaluate_candidates(ParameterGrid(self.param_grid))
   1423
   1424

/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_search.py in evaluate_c
andidates(candidate_params, cv, more_results)
    873                     )
    874
--> 875                 _warn_or_raise_about_fit_failures(out, self.error_score)
    876
    877                 # For callable self.scoring, the return type is only know after

/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py in _warn_
or_raise_about_fit_failures(results, error_score)
    412                 f"Below are more details about the failures:\n{fit_errors_summar
y}"
    413             )
--> 414             raise ValueError(all_fits_failed_message)
    415
    416         else:

ValueError:
All the 59940 fits failed.
It is very likely that your model is misconfigured.
You can try to debug the error by setting error_score='raise'.

Below are more details about the failures:
--------------------------------------------------------------------------------
11988 fits failed with the following error:
Traceback (most recent call last):
```

```
  File "/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py",
 line 729, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/base.py", line 1152, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/svm/_base.py", line 190, in fit
    X, y = self._validate_data(
  File "/usr/local/lib/python3.10/dist-packages/sklearn/base.py", line 622, in _validate
_data
    X, y = check_X_y(X, y, **check_params)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py", line 1146,
 in check_X_y
    X = check_array(
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py", line 915,
 in check_array
    array = _asarray_with_order(array, order=order, dtype=dtype, xp=xp)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/_array_api.py", line 380,
 in _asarray_with_order
    array = numpy.asarray(array, order=order, dtype=dtype)
  File "/usr/local/lib/python3.10/dist-packages/pandas/core/series.py", line 953, in __a
rray__
    arr = np.asarray(values, dtype=dtype)
ValueError: could not convert string to float: '/content/drive/My Drive/project/dataset/
cataract/_213_1709362.jpg'

--------------------------------------------------------------------------------
47952 fits failed with the following error:
Traceback (most recent call last):
  File "/usr/local/lib/python3.10/dist-packages/sklearn/model_selection/_validation.py",
 line 729, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/base.py", line 1152, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/svm/_base.py", line 190, in fit
    X, y = self._validate_data(
  File "/usr/local/lib/python3.10/dist-packages/sklearn/base.py", line 622, in _validate
_data
    X, y = check_X_y(X, y, **check_params)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py", line 1146,
 in check_X_y
    X = check_array(
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py", line 915,
 in check_array
    array = _asarray_with_order(array, order=order, dtype=dtype, xp=xp)
  File "/usr/local/lib/python3.10/dist-packages/sklearn/utils/_array_api.py", line 380,
 in _asarray_with_order
    array = numpy.asarray(array, order=order, dtype=dtype)
  File "/usr/local/lib/python3.10/dist-packages/pandas/core/series.py", line 953, in __a
rray__
    arr = np.asarray(values, dtype=dtype)
ValueError: could not convert string to float: '/content/drive/My Drive/project/dataset/
glaucoma/_318_5873639.jpg'
```

In [269…

```
print(f"grid score:{grid_search.score}")
```

```
grid score:<bound method BaseSearchCV.score of GridSearchCV(estimator=SVC(),
             param_grid={'C': [1, 10, 0.1],
                         'gamma': [0.0001, 0.0002, 0.00030000000000000003,
                                   0.0004, 0.0005, 0.0006000000000000001,
                                   0.0007000000000000001, 0.0008,
                                   0.0009000000000000001, 0.001, 0.0011,
                                   0.0012000000000000001, 0.0013000000000000002,
                                   0.0014000000000000002, 0.0015, 0.0016,
                                   0.0017000000000000001, 0.0018000000000000002,
                                   0.0019000000000000002, 0.002, 0.0021, 0.0022,
                                   0.0023, 0.0024, 0.0025, 0.0026, 0.0027,
```

```
                                0.0028, 0.0029, 0.003, ...],
                       'kernel': ('sigmoid', 'rbf', 'poly', 'linear')})>
```

In [ ]:
```
# ploting tecniques using this model
```

In [270…
```
# Define early stopping callback
from tensorflow.keras.callbacks import EarlyStopping
early_stopping = EarlyStopping(patience=5, restore_best_weights=True)

# Fit the model with callbacks
history = model.fit(train_data,
                    validation_data=valid_data,
                    epochs=5,
                    callbacks=[early_stopping])
```

```
Epoch 1/5
  5/106 ▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱▱ 5:09 3s/step - accuracy: 0.9205 - loss: 0.2796
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
<ipython-input-270-d27abf7d4aba> in <cell line: 6>()
      4
      5 # Fit the model with callbacks
----> 6 history = model.fit(train_data,
      7                     validation_data=valid_data,
      8                     epochs=5,

/usr/local/lib/python3.10/dist-packages/keras/src/utils/traceback_utils.py in error_hand
ler(*args, **kwargs)
    115         filtered_tb = None
    116         try:
--> 117             return fn(*args, **kwargs)
    118         except Exception as e:
    119             filtered_tb = _process_traceback_frames(e.__traceback__)

/usr/local/lib/python3.10/dist-packages/keras/src/backend/tensorflow/trainer.py in fit(s
elf, x, y, batch_size, epochs, verbose, callbacks, validation_split, validation_data, sh
uffle, class_weight, sample_weight, initial_epoch, steps_per_epoch, validation_steps, va
lidation_batch_size, validation_freq)
    316                 for step, iterator in epoch_iterator.enumerate_epoch():
    317                     callbacks.on_train_batch_begin(step)
--> 318                     logs = self.train_function(iterator)
    319                     logs = self._pythonify_logs(logs)
    320                     callbacks.on_train_batch_end(step, logs)

/usr/local/lib/python3.10/dist-packages/tensorflow/python/util/traceback_utils.py in err
or_handler(*args, **kwargs)
    148     filtered_tb = None
    149     try:
--> 150       return fn(*args, **kwargs)
    151     except Exception as e:
    152       filtered_tb = _process_traceback_frames(e.__traceback__)

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/pol
ymorphic_function.py in __call__(self, *args, **kwds)
    831
    832       with OptionalXlaContext(self._jit_compile):
--> 833         result = self._call(*args, **kwds)
    834
    835       new_tracing_count = self.experimental_get_tracing_count()

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/pol
ymorphic_function.py in _call(self, *args, **kwds)
    876       # In this case we have not created variables on the first call. So we can
    877       # run the first trace but we should fail if variables are created.
--> 878       results = tracing_compilation.call_function(
```

```
    879           args, kwds, self._variable_creation_config
    880       )

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/tracing_compilation.py in call_function(args, kwargs, tracing_options)
    137   bound_args = function.function_type.bind(*args, **kwargs)
    138   flat_inputs = function.function_type.unpack_inputs(bound_args)
--> 139   return function._call_flat(  # pylint: disable=protected-access
    140       flat_inputs, captured_inputs=function.captured_inputs
    141   )

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/concrete_function.py in _call_flat(self, tensor_inputs, captured_inputs)
   1320         and executing_eagerly):
   1321       # No tape is watching; skip to running the function.
-> 1322       return self._inference_function.call_preflattened(args)
   1323     forward_backward = self._select_forward_and_backward_functions(
   1324         args,

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/atomic_function.py in call_preflattened(self, args)
    214   def call_preflattened(self, args: Sequence[core.Tensor]) -> Any:
    215     """Calls with flattened tensor inputs and returns the structured output."""
--> 216     flat_outputs = self.call_flat(*args)
    217     return self.function_type.pack_output(flat_outputs)
    218

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/polymorphic_function/atomic_function.py in call_flat(self, *args)
    249         with record.stop_recording():
    250           if self._bound_context.executing_eagerly():
--> 251             outputs = self._bound_context.call_function(
    252                 self.name,
    253                 list(args),

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/context.py in call_function(self, name, tensor_inputs, num_outputs)
   1550     cancellation_context = cancellation.context()
   1551     if cancellation_context is None:
-> 1552       outputs = execute.execute(
   1553           name.decode("utf-8"),
   1554           num_outputs=num_outputs,

/usr/local/lib/python3.10/dist-packages/tensorflow/python/eager/execute.py in quick_execute(op_name, num_outputs, inputs, attrs, ctx, name)
     51   try:
     52     ctx.ensure_initialized()
---> 53     tensors = pywrap_tfe.TFE_Py_Execute(ctx._handle, device_name, op_name,
     54                                         inputs, attrs, num_outputs)
     55   except core._NotOkStatusException as e:

KeyboardInterrupt:
```

In [307…

```
# check how history can signifies this model
```

In [305…

```
import matplotlib.pyplot as plt

def plot_training(history):
    # Check if the history object contains accuracy and loss data
    if 'accuracy' in history.history and 'val_accuracy' in history.history:
        # Plot accuracy
        plt.figure(figsize=(12, 6))

        plt.subplot(1, 2, 1)
        plt.plot(history.history['accuracy'], label='Train Accuracy')
```

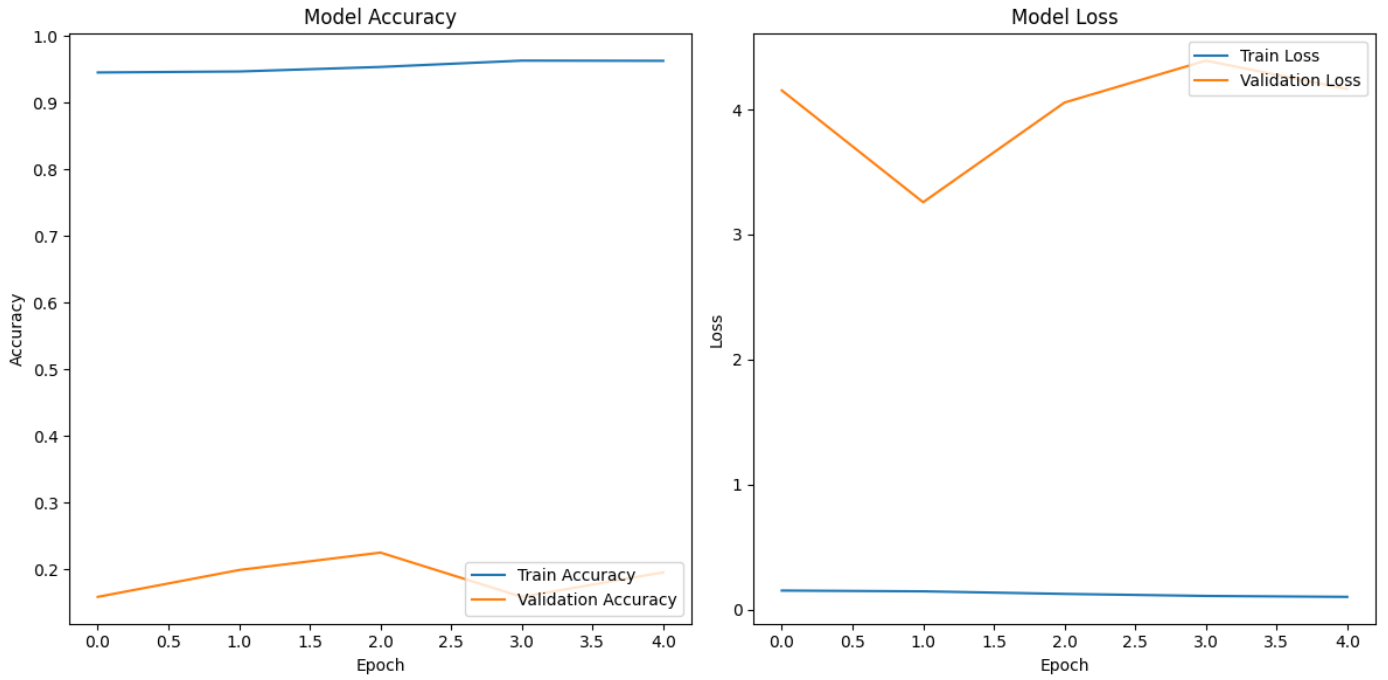
```
        plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
        plt.title('Model Accuracy')
        plt.xlabel('Epoch')
        plt.ylabel('Accuracy')
        plt.legend(loc='lower right')

    if 'loss' in history.history and 'val_loss' in history.history:
        # Plot loss
        plt.subplot(1, 2, 2)
        plt.plot(history.history['loss'], label='Train Loss')
        plt.plot(history.history['val_loss'], label='Validation Loss')
        plt.title('Model Loss')
        plt.xlabel('Epoch')
        plt.ylabel('Loss')
        plt.legend(loc='upper right')

    plt.tight_layout()
    plt.show()
```

In [306…

```
plot_training(history)
```




In [ ]:

```
#
```

In [271…

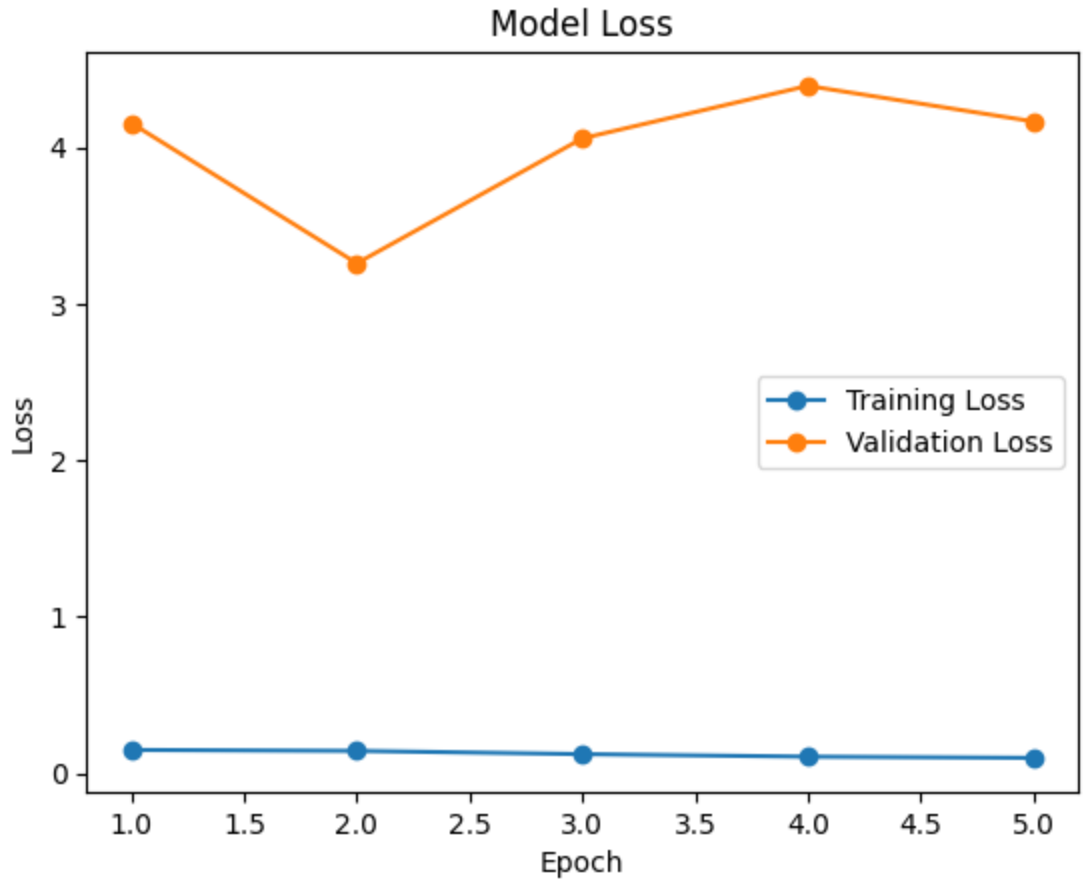
```
# Define epochs
epochs = range(1, len(history.history['loss']) + 1)

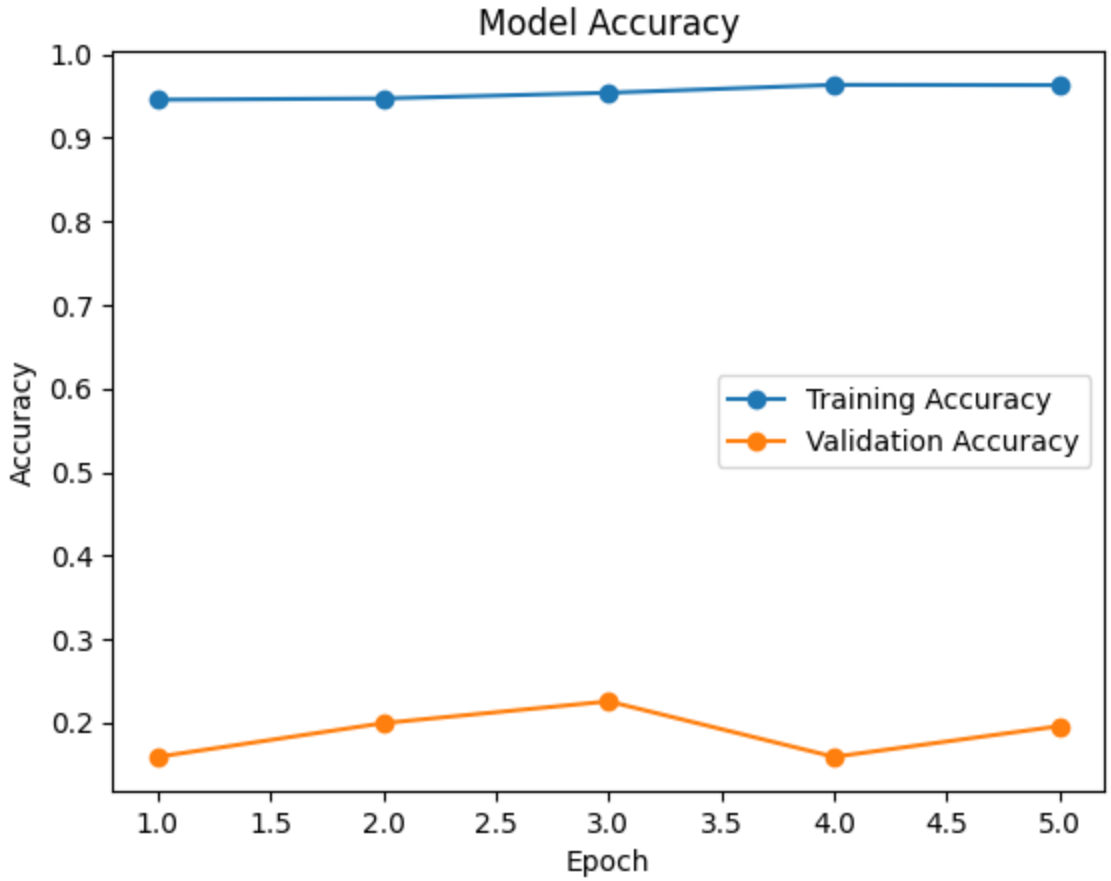
# Plot training & validation loss
plt.plot(epochs, history.history['loss'], label='Training Loss', marker='o')
plt.plot(epochs, history.history['val_loss'], label='Validation Loss', marker='o')
plt.title('Model Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()



# Plot training & validation accuracy
plt.plot(epochs, history.history['accuracy'], label='Training Accuracy', marker='o')
plt.plot(epochs, history.history['val_accuracy'], label='Validation Accuracy', marker='o
plt.title('Model Accuracy')
plt.xlabel('Epoch')
```

```
plt.ylabel('Accuracy')
plt.legend()
plt.show()
```

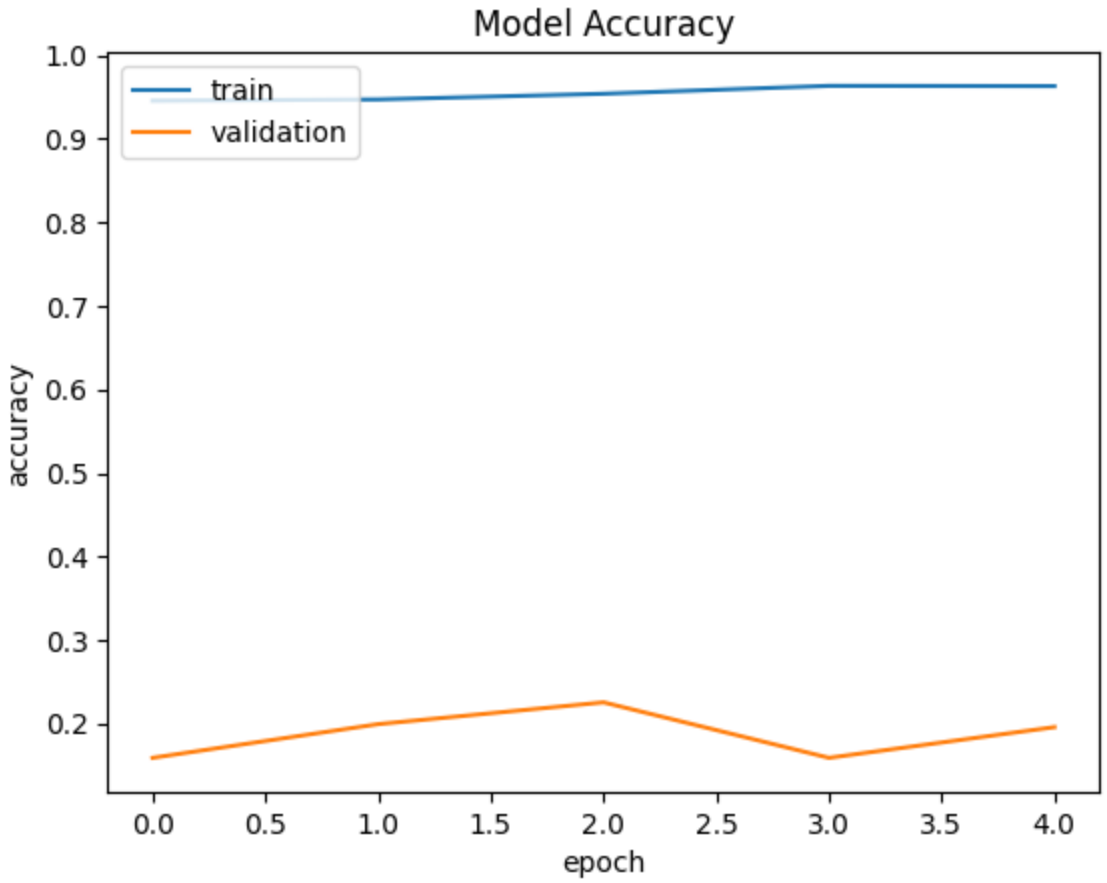



In [272…

```
# Plot accuracy
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
```

```
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'validation'], loc='upper left')
plt.show()
```

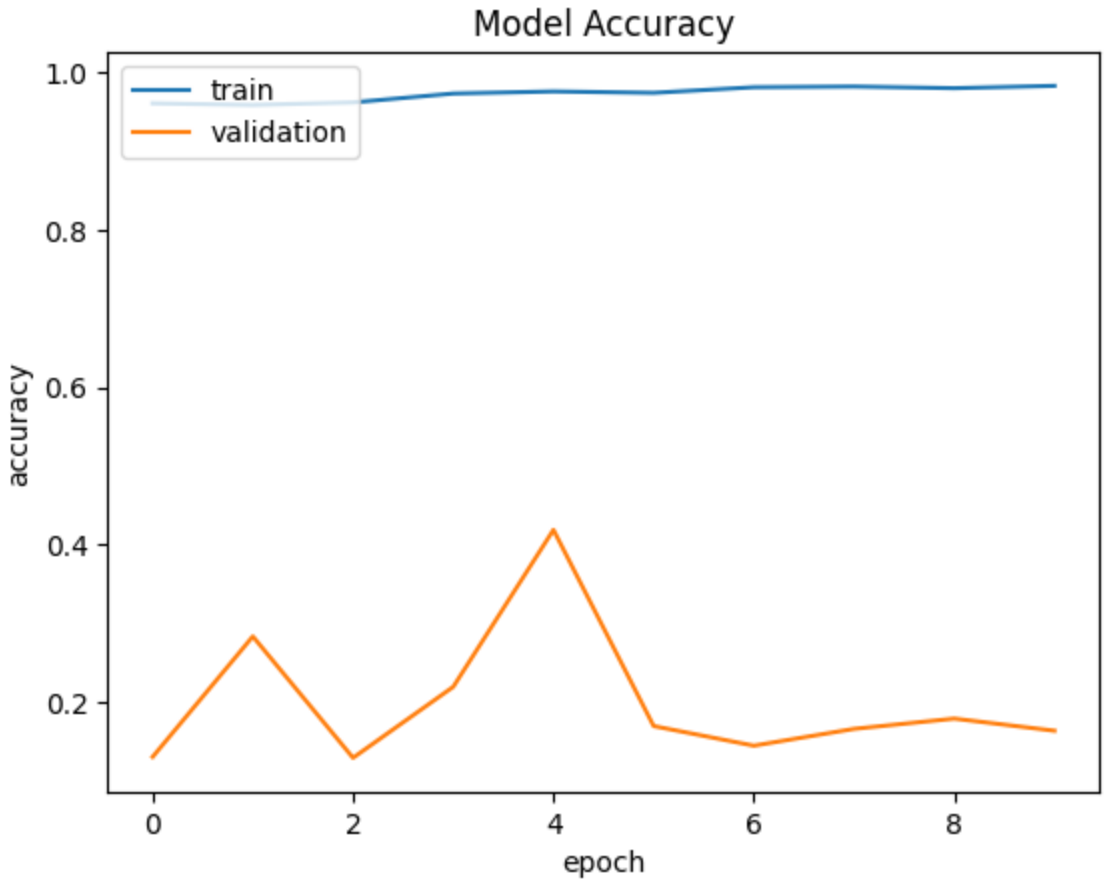



In [308…

```
# plot with help of hist data
```

In [273…

```
plt.plot(his.history['accuracy'])
plt.plot(his.history['val_accuracy'])
plt.title('Model Accuracy')
plt.ylabel('accuracy')
plt.xlabel('epoch')
plt.legend(['train', 'validation'], loc='upper left')
plt.show()
```



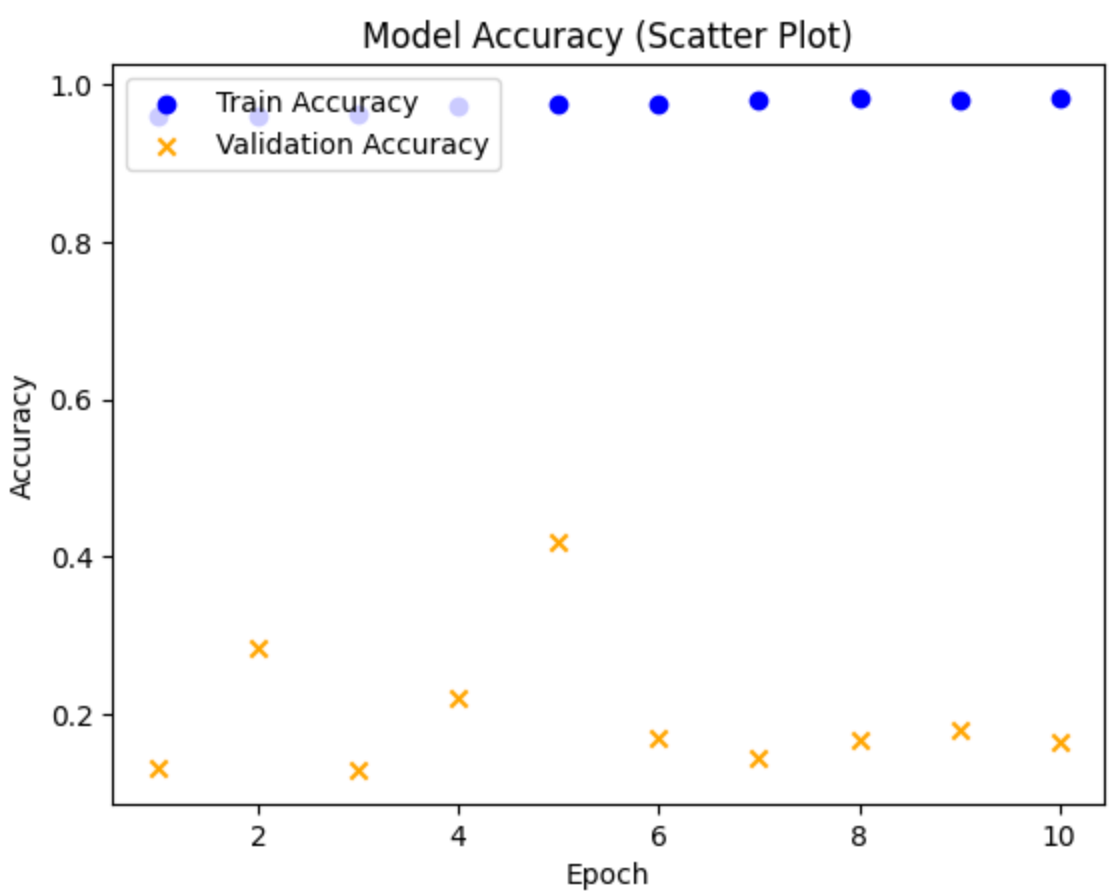

In [309…
```
# some extra plotting techniques to show by the uses of visualization process
```

In [ ]:
```
# sactter plot
```

In [278…
```
import matplotlib.pyplot as plt

epochs = range(1, len(his.history['accuracy']) + 1)

plt.scatter(epochs, his.history['accuracy'], label='Train Accuracy', color='blue', marke
plt.scatter(epochs, his.history['val_accuracy'], label='Validation Accuracy', color='ora
plt.title('Model Accuracy (Scatter Plot)')
plt.ylabel('Accuracy')
plt.xlabel('Epoch')
plt.legend(loc='upper left')
plt.show()
```



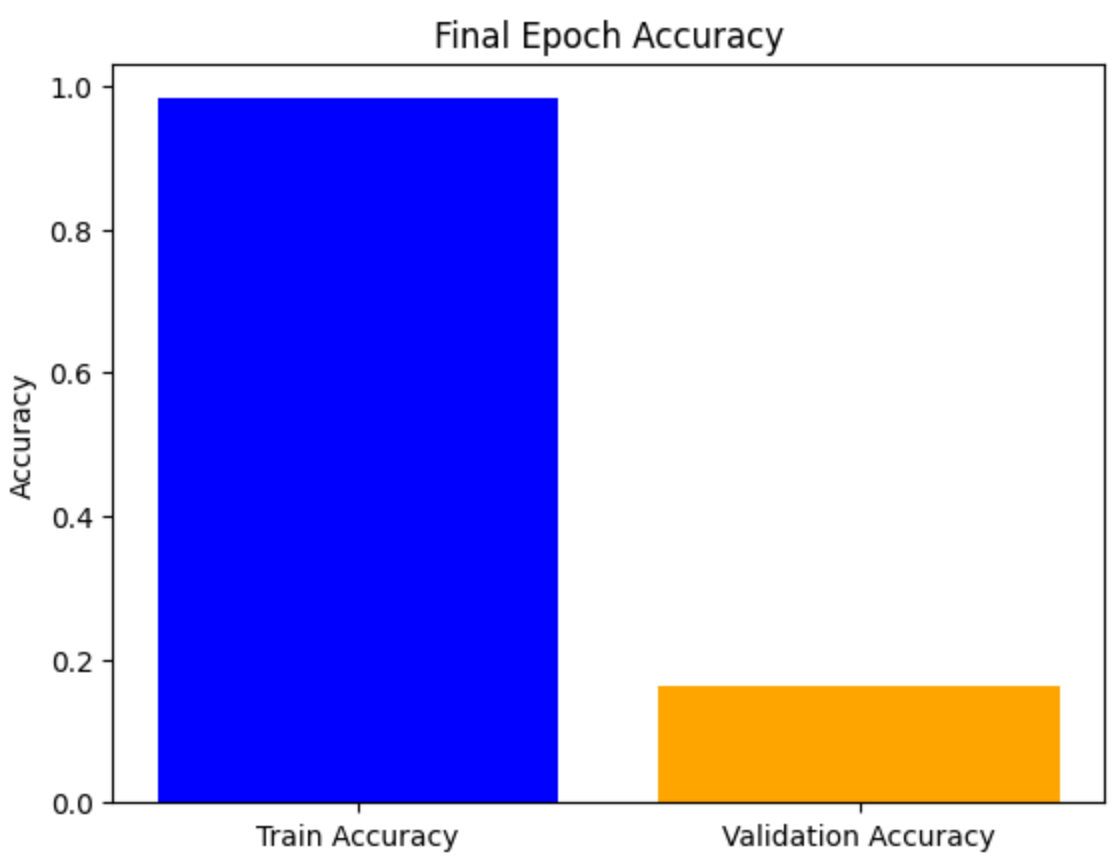

In [ ]:
```
# bar plot
```

In [279…
```
import numpy as np

# Assuming you want to plot accuracy at the last epoch
train_acc = his.history['accuracy'][-1]
val_acc = his.history['val_accuracy'][-1]

accuracy_data = {'Train Accuracy': train_acc, 'Validation Accuracy': val_acc}
names = list(accuracy_data.keys())
values = list(accuracy_data.values())

plt.bar(names, values, color=['blue', 'orange'])
plt.title('Final Epoch Accuracy')
plt.ylabel('Accuracy')
plt.show()
```

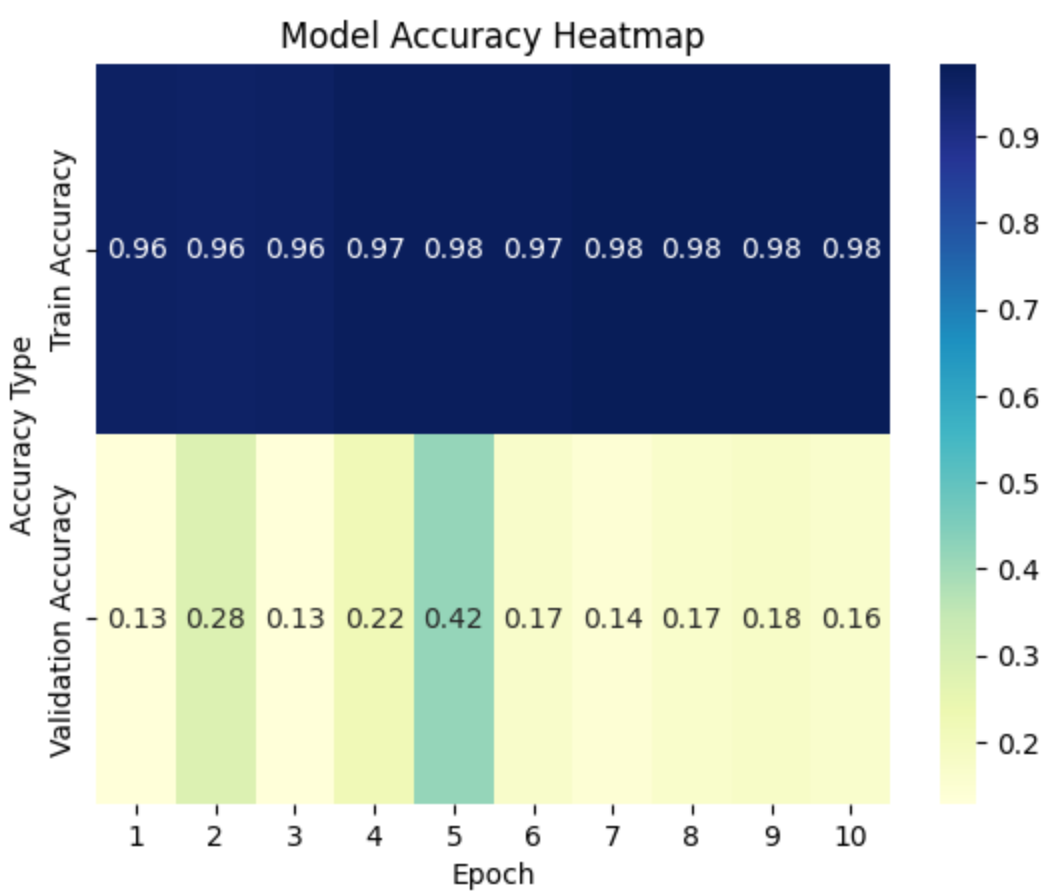



In [ ]:
```
# heatmap
```

In [280…
```
import seaborn as sns

data = {
    'Epoch': list(range(1, len(his.history['accuracy']) + 1)),
    'Train Accuracy': his.history['accuracy'],
    'Validation Accuracy': his.history['val_accuracy']
}

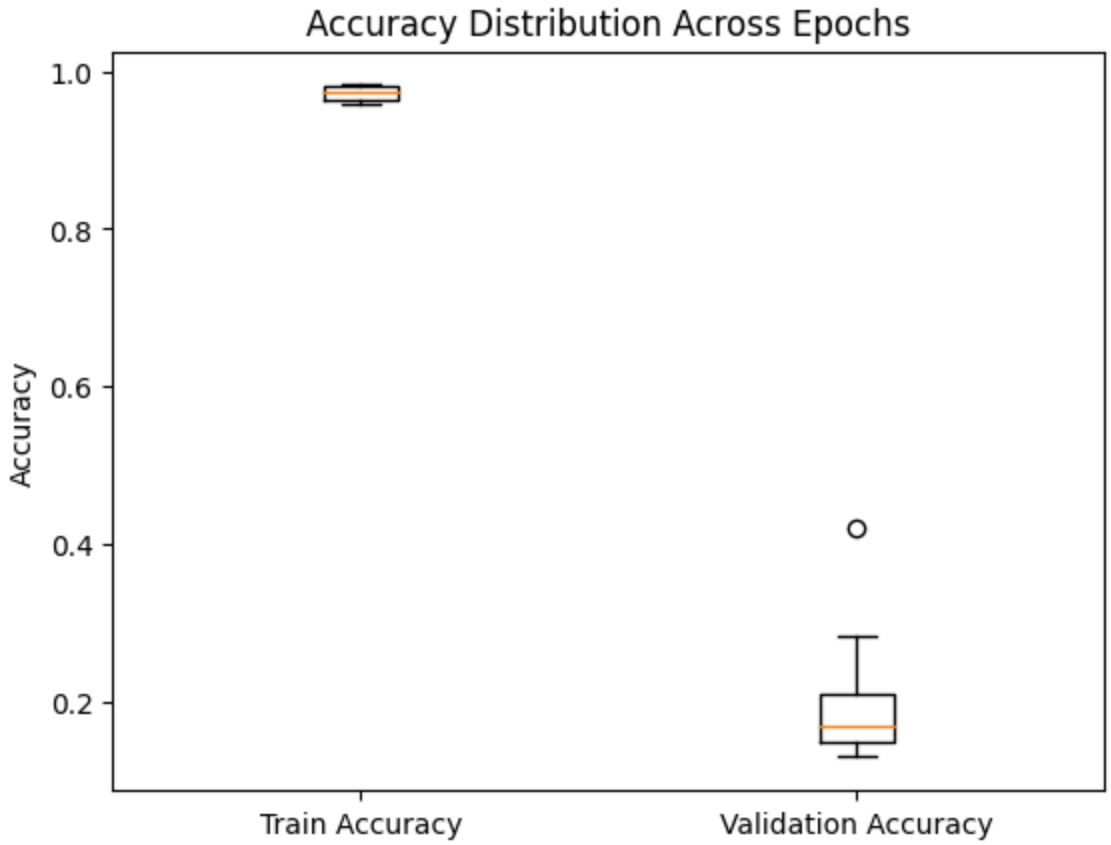
sns.heatmap(pd.DataFrame(data).set_index('Epoch').T, annot=True, cmap='YlGnBu')
plt.title('Model Accuracy Heatmap')
plt.ylabel('Accuracy Type')
plt.xlabel('Epoch')
plt.show()
```




In [ ]:
```
# box plot
```

In [281…
```
accuracy_data = [
    his.history['accuracy'],
    his.history['val_accuracy']
]

plt.boxplot(accuracy_data, labels=['Train Accuracy', 'Validation Accuracy'])
plt.title('Accuracy Distribution Across Epochs')
plt.ylabel('Accuracy')
plt.show()
```




In [345…
```
# precision and recall measure
```

In [310…
```
from sklearn.metrics import precision_score, recall_score, classification_report
import numpy as np
import matplotlib.pyplot as plt
```

In [314…
```
print(x_test.shape)
```

```
(844,)
```

In [322…
```
x_test = x_test.reshape(844, 1)
```

In [325…
```
x_test
```

Out[325]:
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       ['/content/drive/My Drive/project/dataset/glaucoma/365_left.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/_11_7158929.jpg'],
       ['/content/drive/My Drive/project/dataset/normal/2919_right.jpg'],
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g'],
       ['/content/drive/My Drive/project/dataset/glaucoma/_81_2700389.jpg'],
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/10970_right.jpe
g'],
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       ['/content/drive/My Drive/project/dataset/glaucoma/1434_left.jpg'],
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       ['/content/drive/My Drive/project/dataset/normal/3100_right.jpg'],
       ['/content/drive/My Drive/project/dataset/glaucoma/_257_1527283.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/_248_3607543.jpg'],
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/11161_left.jpe
g'],
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g'],
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       ['/content/drive/My Drive/project/dataset/glaucoma/1318_left.jpg'],
       ['/content/drive/My Drive/project/dataset/glaucoma/1246_left.jpg'],
       ['/content/drive/My Drive/project/dataset/normal/2501_left.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/999_right.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/_249_4807123.jpg'],
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/11067_left.jpe
g'],
       ['/content/drive/My Drive/project/dataset/normal/2697_right.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/2152_left.jpg'],
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/10814_right.jpe
g'],
       ['/content/drive/My Drive/project/dataset/cataract/cataract_074.png'],
       ['/content/drive/My Drive/project/dataset/normal/3405_left.jpg'],
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g'],
```

```
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/10116_left.jpe
g'],
       ['/content/drive/My Drive/project/dataset/cataract/cataract_051.png'],
       ['/content/drive/My Drive/project/dataset/glaucoma/Glaucoma_076.png'],
       ['/content/drive/My Drive/project/dataset/glaucoma/_191_4454313.jpg'],
       ['/content/drive/My Drive/project/dataset/normal/2426_left.jpg'],
       ['/content/drive/My Drive/project/dataset/diabetic_retinopathy/10644_right.jpe
g'],
       ['/content/drive/My Drive/project/dataset/normal/2690_left.jpg'],
       ['/content/drive/My Drive/project/dataset/cataract/_172_4553386.jpg'],
       ['/content/drive/My Drive/project/dataset/glaucoma/_278_2942123.jpg'],
       ['/content/drive/My Drive/project/dataset/glaucoma/_63_5036155.jpg']],
      dtype=object)
```

In [335…

```
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense

model = Sequential()
model.add(Conv2D(32, (3, 3), activation='relu', input_shape=(224, 224, 3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dense(128, activation='relu'))
model.add(Dense(num_classes, activation='softmax'))

model.compile(optimizer='adam', loss='categorical_crossentropy', metrics=['accuracy'])
```

```
/usr/local/lib/python3.10/dist-packages/keras/src/layers/convolutional/base_conv.py:107:
UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Se
quential models, prefer using an `Input(shape)` object as the first layer in the model i
nstead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

In [344…

```
y_pred = model.predict(x_test)

# Convert predictions to class indices
y_pred_classes = np.argmax(y_pred, axis=1)

# Assuming y_test is one-hot encoded
y_true_classes = np.argmax(y_test, axis=1)

# Calculate precision and recall
from sklearn.metrics import precision_score, recall_score, classification_report

precision = precision_score(y_true_classes, y_pred_classes, average='weighted')
recall = recall_score(y_true_classes, y_pred_classes, average='weighted')

print(f'Precision: {precision}')
print(f'Recall: {recall}')

# Print classification report
class_names = [...]
report = classification_report(y_true_classes, y_pred_classes, target_names=class_names)
print(report)
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-344-7ad88fa1ef77> in <cell line: 2>()
      1 # Make predictions
----> 2 y_pred = model.predict(x_test)
      3
      4 # Convert predictions to class indices
      5 y_pred_classes = np.argmax(y_pred, axis=1)

/usr/local/lib/python3.10/dist-packages/keras/src/utils/traceback_utils.py in error_hand
ler(*args, **kwargs)
```

```
    120             # To get the full stack trace, call:
    121             # `keras.config.disable_traceback_filtering()`
--> 122             raise e.with_traceback(filtered_tb) from None
    123         finally:
    124             del filtered_tb

/usr/local/lib/python3.10/dist-packages/keras/src/models/functional.py in _adjust_input_
rank(self, flat_inputs)
    242                     adjusted.append(ops.expand_dims(x, axis=-1))
    243                     continue
--> 244             raise ValueError(
    245                 f"Invalid input shape for input {x}. Expected shape "
    246                 f"{ref_shape}, but input has incompatible shape {x.shape}"

ValueError: Exception encountered when calling Sequential.call().

Invalid input shape for input Tensor("sequential_18_1/Cast:0", shape=(32, 1), dtype=floa
t32). Expected shape (None, 224, 224, 3), but input has incompatible shape (32, 1)

Arguments received by Sequential.call():
  • inputs=tf.Tensor(shape=(32, 1), dtype=string)
  • training=False
  • mask=None
```

In [ ]:

In [ ]:

In [ ]: