

Import basic libraries

More libraries are imported lateer.

I decided to import each library just where it's used.

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

Mounted at /content/drive

```
In [ ]: import numpy as np
import tensorflow as tf
```

Define some useful constants

```
In [ ]: PATH = "path"
LABEL = "label"
AK = 'Ak'
ALA_IDRIS = "Ala_Idris"
BUZGULU = "Buzgulu"
DIMNIT = 'Dimnit'
NAZLI = 'Nazli'

IMG_HEIGHT = 255
IMG_WIDTH = 255
image_shape = (IMG_WIDTH, IMG_HEIGHT, 3)
image_size = (IMG_WIDTH, IMG_HEIGHT)
```

Read the dataset and a quick review

We just read the file paths. the libraries will open and process the images automatically

```
In [ ]: import os

dataset_path = "/content/drive/MyDrive/Grapevine_Leaves_Image_Dataset"
leaves_labels = [AK, ALA_IDRIS, BUZGULU, DIMNIT, NAZLI]

for label in leaves_labels:
    print(f"{label}: {len(os.listdir(os.path.join(dataset_path, label)))} images")
```

Ak: 100 images
Ala_Idris: 100 images
Buzgulu: 100 images
Dimnit: 100 images
Nazli: 100 images

Define a simple function to make a DataFrame out of each kink of leaf

```
In [ ]: import pandas as pd

def makeDf(label):
    df = pd.DataFrame()
    images = os.listdir(os.path.join(dataset_path, label))
    df[PATH] = [os.path.join(dataset_path, label, image_filename) for image_filename in images if image_filename.endswith('.jpg')]
    df[LABEL] = label
    return df
```

Building the datasets

```
In [ ]: dfs = dict()
dfs[AK] = makeDf(AK)
dfs[ALA_IDRIS] = makeDf(ALA_IDRIS)
dfs[BUZGULU] = makeDf(BUZGULU)
dfs[DIMNIT] = makeDf(DIMNIT)
dfs[NAZLI] = makeDf(NAZLI)
```

Let's see how it looks

```
In [ ]: dfs[AK]
```

Out[]:

	path	label
0	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
1	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
2	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
3	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
4	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
...
95	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
96	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
97	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
98	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak
99	/content/drive/MyDrive/Grapevine_Leaves_Image_...	Ak

100 rows × 2 columns

Let's see a couple of examples

In []:

```
import matplotlib.pyplot as plt
from PIL import Image

figure, axis = plt.subplots(1, len(leaves_labels), figsize=(25,5))
for i, label in enumerate(leaves_labels):
    axis[i].imshow(Image.open(dfs[label][PATH][50]))
    axis[i].axis('off')
    # axis[i].title(label)
    axis[i].set_title(label)

# plt.imshow(Image.open(ak_df[PATH][0]))
# plt.subplot()
```



Split the data to "Test", "Validation" and "Train"

To make the datasets perfectly balanced, instead of "mix then split" i did "split then mix" the 5 kinds of leaves.

In []:

```
from sklearn.model_selection import train_test_split
x_trains = pd.DataFrame()
y_trains = pd.DataFrame()

x_validations = pd.DataFrame()
y_validations = pd.DataFrame()

x_tests = pd.DataFrame()
y_tests = pd.DataFrame()

for label in leaves_labels:
    label_df = dfs[label]
    label_Xs = label_df[PATH]
    label_Ys = label_df[LABEL]
    label_x_train, label_x_test, label_y_train, label_y_test = train_test_split(label_Xs, label_Ys, test_size=0.2, random_state=42)

    label_x_train, label_x_val, label_y_train, label_y_val = train_test_split(label_x_train, label_y_train, test_size=0.2, random_state=42)
    x_trains = pd.concat([x_trains, label_x_train])
    y_trains = pd.concat([y_trains, label_y_train])

    x_validations = pd.concat([x_validations, label_x_val])
    y_validations = pd.concat([y_validations, label_y_val])

    x_tests = pd.concat([x_tests, label_x_test])
    y_tests = pd.concat([y_tests, label_y_test])

x_trains.rename({0: PATH}, axis=1, inplace=True)
x_validations.rename({0: PATH}, axis=1, inplace=True)
y_tests.rename({0: PATH}, axis=1, inplace=True)
```

```
y_trains.rename({0: LABEL}, axis=1, inplace=True)
y_validations.rename({0: LABEL}, axis=1, inplace=True)
y_tests.rename({0: LABEL}, axis=1, inplace=True)
```

Quick look at the shapes

```
In [ ]: print(f"x_trains shape: {x_trains.shape}")
        print(f"y_trains shape: {y_trains.shape}")
        print(f"x_validations shape: {x_validations.shape}")
        print(f"y_validations shape: {y_validations.shape}")
        print(f"x_tests shape: {x_tests.shape}")
        print(f"y_tests shape: {y_tests.shape}")

x_trains shape: (320, 1)
y_trains shape: (320, 1)
x_validations shape: (80, 1)
y_validations shape: (80, 1)
x_tests shape: (100, 1)
y_tests shape: (100, 1)
```

Quick review of the train part for instance

```
In [ ]: x_trains
```

Out[]:

	path
82	/content/drive/MyDrive/Grapevine_Leaves_Image_...
84	/content/drive/MyDrive/Grapevine_Leaves_Image_...
57	/content/drive/MyDrive/Grapevine_Leaves_Image_...
56	/content/drive/MyDrive/Grapevine_Leaves_Image_...
72	/content/drive/MyDrive/Grapevine_Leaves_Image_...
...	...
49	/content/drive/MyDrive/Grapevine_Leaves_Image_...
63	/content/drive/MyDrive/Grapevine_Leaves_Image_...
74	/content/drive/MyDrive/Grapevine_Leaves_Image_...
93	/content/drive/MyDrive/Grapevine_Leaves_Image_...
41	/content/drive/MyDrive/Grapevine_Leaves_Image_...

320 rows × 1 columns

And the y_train

```
In [ ]: y_trains
```

Out[]:

	label
82	Ak
84	Ak
57	Ak
56	Ak
72	Ak
...	...
49	Nazli
63	Nazli
74	Nazli
93	Nazli
41	Nazli

320 rows × 1 columns

To use these datasets and feed them to the data generator we need to combine the x and y parts

```
In [ ]: train_data = pd.concat([x_trains, y_trains], axis=1)
        validation_data = pd.concat([x_validations, y_validations], axis=1)
        test_data = pd.concat([x_tests, y_tests], axis=1)
```

First we define two kinds of generators.

- data_generator: for the trains and validations augmentation
- test_data_generator: a very simple preprocessing to be compatible with the models in size ### And out of these two genertors we build the augmented data for each part

```
In [ ]: from keras_preprocessing.image import ImageDataGenerator
from keras.applications.imagenet_utils import preprocess_input
from keras.layers import Dense
from keras.models import Model
data_generator = ImageDataGenerator(
    rotation_range=20,
    zoom_range=0.10,
    brightness_range=[0.6, 1.4],
    channel_shift_range=0.7,
    width_shift_range=0.15,
    height_shift_range=0.15,
    shear_range=0.15,
    horizontal_flip=True,
    vertical_flip=True,
    fill_mode='nearest',
    preprocessing_function=preprocess_input
)

test_data_generator = ImageDataGenerator(
    preprocessing_function=preprocess_input
)

train_generator = data_generator.flow_from_dataframe(
    train_data,
    x_col=PATH,
    y_col=LABEL,
    target_size=image_size,
    batch_size=32,
    class_mode="categorical",
    shuffle=True,
)

val_generator = data_generator.flow_from_dataframe(
    validation_data,
    x_col=PATH,
    y_col=LABEL,
    target_size=image_size,
    batch_size=32,
    class_mode="categorical",
    shuffle=True,
)

test_generator = test_data_generator.flow_from_dataframe(
    test_data,
    x_col=PATH,
    y_col=LABEL,
    target_size=image_size,
    batch_size=32,
    class_mode="categorical",
    shuffle=False,
)
```

Found 320 validated image filenames belonging to 5 classes.
 Found 80 validated image filenames belonging to 5 classes.
 Found 100 validated image filenames belonging to 5 classes.

Let's see the augmented data among their original ones

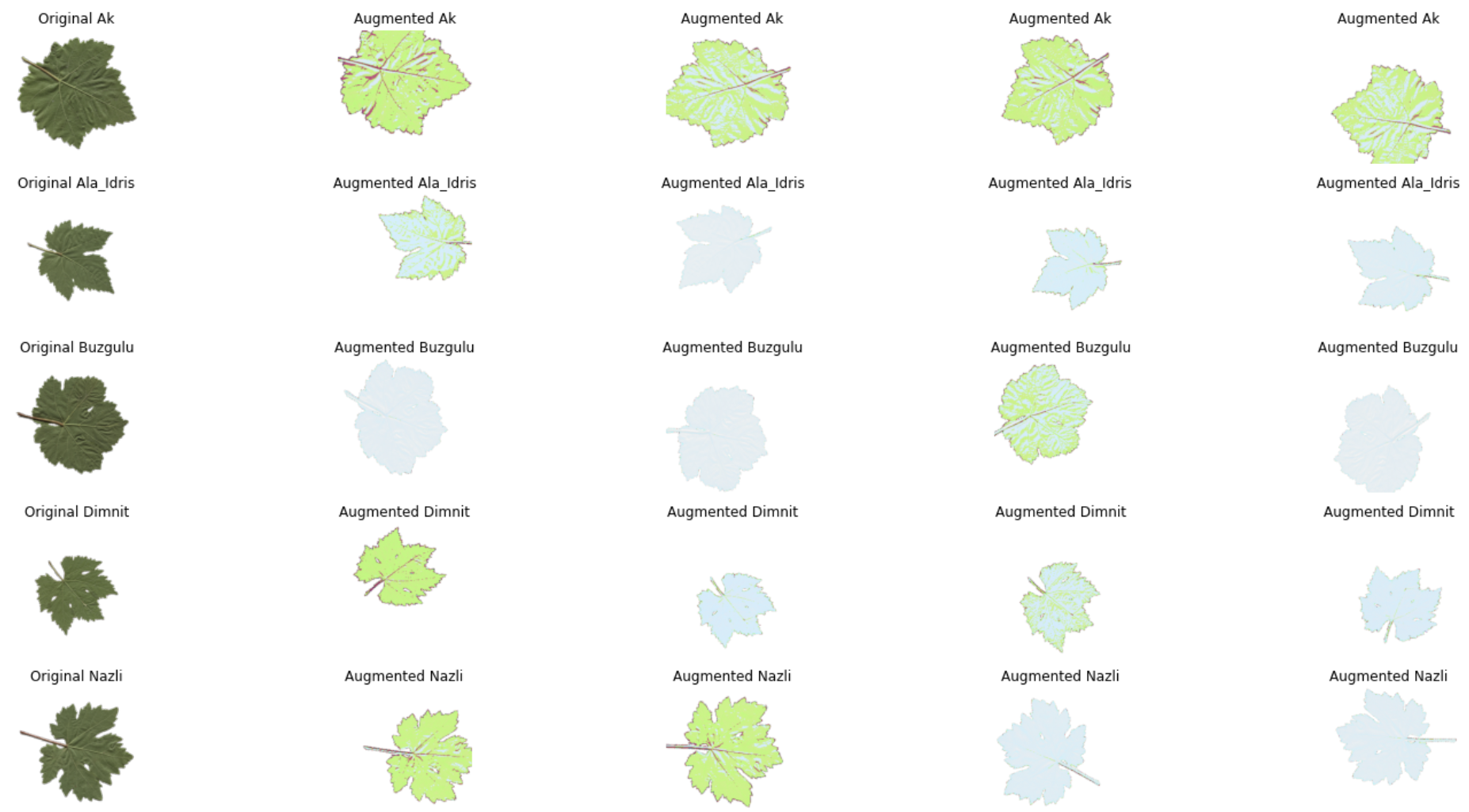
```
In [ ]: from numpy import expand_dims
plt.figure(figsize = (20,20))
paths = [dfs[label][PATH][50] for label in leaves_labels]
fig_num = 0
for i, path in enumerate(paths):
    data = Image.open(path)
    data = data.resize((224,224))
    samples = expand_dims(data, 0)
    it = data_generator.flow(samples, batch_size=1)

    # Original image
    plt.subplot(10,5, fig_num+1)
    plt.imshow(data)
    plt.axis('off')
    plt.title(f"Original {leaves_labels[i]}")
    # Augmented images
    for _ in range(4):
        fig_num += 1
        plt.subplot(10,5, fig_num+1)
        batch = it.next()
        image = batch[0].astype('uint8')
        plt.axis('off')
```

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```
plt.title(f"Augmented {leaves_labels[i]}")
fig_num += 1

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



Here we just define a simple callback to use in our model to do stuff better

```
In [ ]: model_check_point = tf.keras.callbacks.ModelCheckpoint("save_model_xception.h5",
                                                             save_best_only=True
)
# early_stopping = tf.keras.callbacks.EarlyStopping(
#     patience=10,
#     min_delta=0.001,
#     restore_best_weights=True,
# )
callbacks = [model_check_point]
```

An important function to print the result and plot the corresponding diagrams

```
In [ ]: from sklearn.metrics import accuracy_score, confusion_matrix, classification_report
import seaborn as sns
def report_results(model, y_true, y_predicted):
    y_predicted = np.argmax(y_predicted, axis=1)
    labels = (train_generator.class_indices)
    labels = dict((v,k) for k,v in labels.items())
    y_predicted = np.array([labels[k] for k in y_predicted])
    print(f"Accuracy score: {accuracy_score(y_true, y_predicted)}")
    print(classification_report(y_true, y_predicted))
    mat = confusion_matrix(y_true, y_predicted)
    sns.heatmap(mat, annot=True)
```

Another important function to plot the model history progress

```
In [ ]: def plotModelHistory(history):
    plt.figure(figsize=(15,5))
    plt.plot(history.history['accuracy'], label="Training Accuracy")
    plt.plot(history.history['val_accuracy'], label="Validation Accuracy")
    plt.legend(["Training", "Validation"])
    plt.title('Model accuracy')
    plt.ylabel('Accuracy')
    plt.xlabel('Epoch')
    plt.show()

    plt.figure(figsize=(15,5))
    plt.plot(history.history['loss'], label="Training loss")
    plt.plot(history.history['val_loss'], label="Validation loss")
    plt.legend(["Training", "Validation"])
    plt.title('Model loss')
    plt.ylabel('loss')
    plt.show()
```

Let's run the first model. We use a pretrained model called VGG19 and the build our model with "Model"

Then compile it and fit

```
In [ ]: from tensorflow.keras.applications import VGG19
from keras.layers import GlobalAveragePooling2D
if True: # set to False to skip and go to next parts of code
    vgg19 = VGG19(include_top = False, input_shape=image_shape, weights = 'imagenet')

    for layer in vgg19.layers:
        layer.trainable = False

    x = GlobalAveragePooling2D()(vgg19.output)
    predictions = Dense(5, activation='softmax')(x)

    vgg_model = Model(inputs = vgg19.input, outputs = predictions)

    vgg_model.compile(loss='categorical_crossentropy', optimizer="adam", metrics=['accuracy'])

    history_vgg = vgg_model.fit(
        train_generator,
        validation_data=val_generator,
        epochs=50,
        verbose=2,
        callbacks=callbacks
    )
```


Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/vgg19/vgg19_weights_tf_dim_ordering_tf_kernels_notop.h5

80142336/80134624 [=====] - 1s 0us/step

80150528/80134624 [=====] - 1s 0us/step

Epoch 1/50

10/10 - 174s - loss: 2.1347 - accuracy: 0.2281 - val_loss: 1.9161 - val_accuracy: 0.2875 - 174s/epoch - 17s/step

Epoch 2/50

10/10 - 10s - loss: 1.9100 - accuracy: 0.2719 - val_loss: 1.7975 - val_accuracy: 0.3000 - 10s/epoch - 991ms/step

Epoch 3/50

10/10 - 10s - loss: 1.6268 - accuracy: 0.3625 - val_loss: 1.6682 - val_accuracy: 0.3125 - 10s/epoch - 1s/step

Epoch 4/50

10/10 - 10s - loss: 1.5368 - accuracy: 0.3625 - val_loss: 1.3925 - val_accuracy: 0.4625 - 10s/epoch - 998ms/step

Epoch 5/50

10/10 - 10s - loss: 1.3186 - accuracy: 0.4938 - val_loss: 1.3722 - val_accuracy: 0.4750 - 10s/epoch - 1s/step

Epoch 6/50

10/10 - 10s - loss: 1.2815 - accuracy: 0.4969 - val_loss: 1.3349 - val_accuracy: 0.4500 - 10s/epoch - 992ms/step

Epoch 7/50

10/10 - 10s - loss: 1.1675 - accuracy: 0.5188 - val_loss: 1.3101 - val_accuracy: 0.4250 - 10s/epoch - 1s/step

Epoch 8/50

10/10 - 10s - loss: 1.1558 - accuracy: 0.5469 - val_loss: 1.2692 - val_accuracy: 0.5125 - 10s/epoch - 1s/step

Epoch 9/50

10/10 - 10s - loss: 1.0436 - accuracy: 0.5969 - val_loss: 1.2694 - val_accuracy: 0.5875 - 10s/epoch - 1s/step

Epoch 10/50

10/10 - 10s - loss: 1.0461 - accuracy: 0.5875 - val_loss: 1.0235 - val_accuracy: 0.5750 - 10s/epoch - 1s/step

Epoch 11/50

10/10 - 10s - loss: 1.0133 - accuracy: 0.6531 - val_loss: 1.2127 - val_accuracy: 0.5000 - 10s/epoch - 1s/step

Epoch 12/50

10/10 - 10s - loss: 1.0261 - accuracy: 0.6531 - val_loss: 0.9635 - val_accuracy: 0.6250 - 10s/epoch - 1s/step

Epoch 13/50

10/10 - 10s - loss: 0.9184 - accuracy: 0.6250 - val_loss: 0.8711 - val_accuracy: 0.6875 - 10s/epoch - 1s/step

Epoch 14/50

10/10 - 10s - loss: 0.9411 - accuracy: 0.6625 - val_loss: 0.9721 - val_accuracy: 0.6000 - 10s/epoch - 1s/step

Epoch 15/50

10/10 - 10s - loss: 0.9390 - accuracy: 0.6656 - val_loss: 0.9172 - val_accuracy: 0.6875 - 10s/epoch - 981ms/step

Epoch 16/50

10/10 - 10s - loss: 0.8822 - accuracy: 0.6594 - val_loss: 0.8616 - val_accuracy: 0.6625 - 10s/epoch - 1s/step

Epoch 17/50

10/10 - 10s - loss: 0.8374 - accuracy: 0.6844 - val_loss: 1.0122 - val_accuracy: 0.5875 - 10s/epoch - 1s/step

Epoch 18/50

10/10 - 10s - loss: 0.7977 - accuracy: 0.6938 - val_loss: 0.9771 - val_accuracy: 0.6500 - 10s/epoch - 968ms/step

Epoch 19/50

10/10 - 11s - loss: 0.8079 - accuracy: 0.7156 - val_loss: 0.8517 - val_accuracy: 0.7000 - 11s/epoch - 1s/step

Epoch 20/50

10/10 - 10s - loss: 0.7747 - accuracy: 0.7250 - val_loss: 0.7399 - val_accuracy: 0.7625 - 10s/epoch - 975ms/step

Epoch 21/50

10/10 - 11s - loss: 0.7541 - accuracy: 0.7281 - val_loss: 0.8283 - val_accuracy: 0.6875 - 11s/epoch - 1s/step

Epoch 22/50

10/10 - 10s - loss: 0.7491 - accuracy: 0.7250 - val_loss: 0.7107 - val_accuracy: 0.7375 - 10s/epoch - 969ms/step

Epoch 23/50

10/10 - 11s - loss: 0.7428 - accuracy: 0.7281 - val_loss: 0.6655 - val_accuracy: 0.8125 - 11s/epoch - 1s/step

Epoch 24/50

10/10 - 10s - loss: 0.6960 - accuracy: 0.7688 - val_loss: 0.7431 - val_accuracy: 0.7375 - 10s/epoch - 952ms/step

Epoch 25/50

10/10 - 10s - loss: 0.7263 - accuracy: 0.7594 - val_loss: 0.7281 - val_accuracy: 0.8125 - 10s/epoch - 1s/step

Epoch 26/50

10/10 - 10s - loss: 0.7101 - accuracy: 0.7563 - val_loss: 0.6766 - val_accuracy: 0.7625 - 10s/epoch - 966ms/step

Epoch 27/50

10/10 - 10s - loss: 0.6162 - accuracy: 0.8000 - val_loss: 0.6714 - val_accuracy: 0.8000 - 10s/epoch - 1s/step

Epoch 28/50

10/10 - 10s - loss: 0.6868 - accuracy: 0.7469 - val_loss: 0.6806 - val_accuracy: 0.7375 - 10s/epoch - 1s/step

Epoch 29/50

10/10 - 11s - loss: 0.6394 - accuracy: 0.7719 - val_loss: 0.6170 - val_accuracy: 0.8250 - 11s/epoch - 1s/step

Epoch 30/50

10/10 - 10s - loss: 0.6387 - accuracy: 0.7906 - val_loss: 0.6363 - val_accuracy: 0.8125 - 10s/epoch - 1s/step

Epoch 31/50

10/10 - 10s - loss: 0.6193 - accuracy: 0.7750 - val_loss: 0.6994 - val_accuracy: 0.7750 - 10s/epoch - 1s/step

Epoch 32/50

10/10 - 11s - loss: 0.6146 - accuracy: 0.8156 - val_loss: 0.6479 - val_accuracy: 0.7875 - 11s/epoch - 1s/step

Epoch 33/50

10/10 - 10s - loss: 0.5697 - accuracy: 0.8031 - val_loss: 0.6871 - val_accuracy: 0.7875 - 10s/epoch - 965ms/step

Epoch 34/50

10/10 - 10s - loss: 0.5686 - accuracy: 0.8469 - val_loss: 0.6173 - val_accuracy: 0.8500 - 10s/epoch - 1s/step

Epoch 35/50

10/10 - 10s - loss: 0.5652 - accuracy: 0.8094 - val_loss: 0.6029 - val_accuracy: 0.7625 - 10s/epoch - 1s/step

Epoch 36/50

10/10 - 10s - loss: 0.5647 - accuracy: 0.8281 - val_loss: 0.5975 - val_accuracy: 0.7750 - 10s/epoch - 1s/step

Epoch 37/50

10/10 - 10s - loss: 0.5409 - accuracy: 0.8344 - val_loss: 0.5511 - val_accuracy: 0.8375 - 10s/epoch - 1s/step

Epoch 38/50

10/10 - 10s - loss: 0.5594 - accuracy: 0.8250 - val_loss: 0.5975 - val_accuracy: 0.8125 - 10s/epoch - 1s/step

Epoch 39/50

10/10 - 11s - loss: 0.5415 - accuracy: 0.8219 - val_loss: 0.5956 - val_accuracy: 0.8375 - 11s/epoch - 1s/step

Epoch 40/50

10/10 - 10s - loss: 0.5998 - accuracy: 0.7812 - val_loss: 0.6226 - val_accuracy: 0.8250 - 10s/epoch - 950ms/step

Epoch 41/50

10/10 - 10s - loss: 0.5522 - accuracy: 0.8375 - val_loss: 0.6499 - val_accuracy: 0.8125 - 10s/epoch - 1s/step

Epoch 42/50

10/10 - 10s - loss: 0.5446 - accuracy: 0.8281 - val_loss: 0.5890 - val_accuracy: 0.7750 - 10s/epoch - 962ms/step

Epoch 43/50

10/10 - 11s - loss: 0.5045 - accuracy: 0.8188 - val_loss: 0.6276 - val_accuracy: 0.7875 - 11s/epoch - 1s/step

Epoch 44/50

Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js accuracy: 0.8281 - val_loss: 0.6211 - val_accuracy: 0.7625 - 10s/epoch - 958ms/step

Epoch 45/50
10/10 - 10s - loss: 0.5334 - accuracy: 0.8250 - val_loss: 0.4746 - val_accuracy: 0.8625 - 10s/epoch - 1s/step
Epoch 46/50
10/10 - 10s - loss: 0.5234 - accuracy: 0.8188 - val_loss: 0.5997 - val_accuracy: 0.7500 - 10s/epoch - 993ms/step
Epoch 47/50
10/10 - 10s - loss: 0.5431 - accuracy: 0.8313 - val_loss: 0.5987 - val_accuracy: 0.8250 - 10s/epoch - 1s/step
Epoch 48/50
10/10 - 10s - loss: 0.4995 - accuracy: 0.8406 - val_loss: 0.4299 - val_accuracy: 0.9125 - 10s/epoch - 1s/step
Epoch 49/50
10/10 - 10s - loss: 0.4930 - accuracy: 0.8281 - val_loss: 0.6038 - val_accuracy: 0.7750 - 10s/epoch - 986ms/step
Epoch 50/50
10/10 - 10s - loss: 0.4894 - accuracy: 0.8406 - val_loss: 0.5121 - val_accuracy: 0.8250 - 10s/epoch - 1s/step

Now evaluate the model

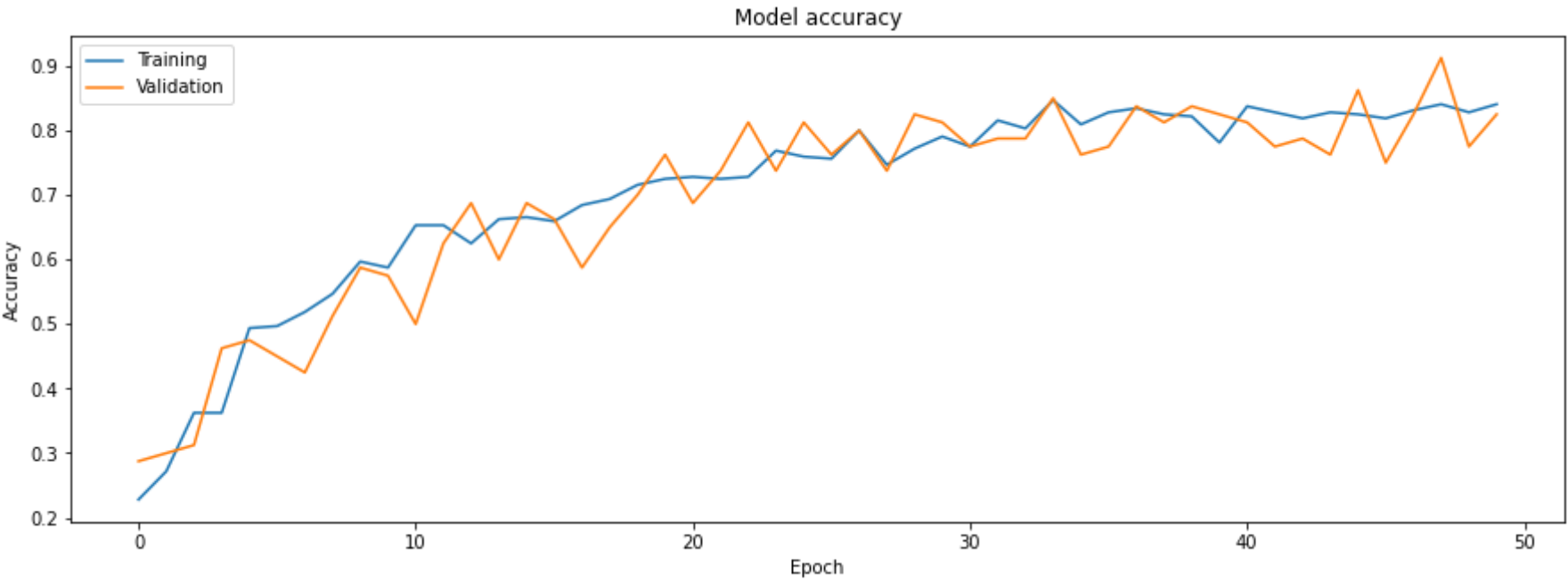
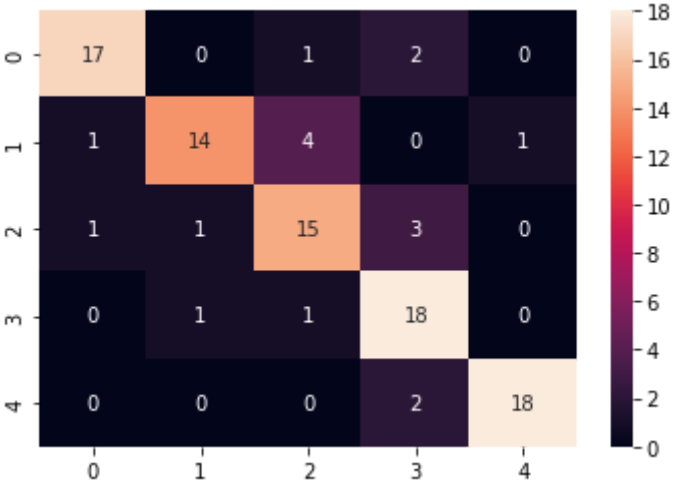
```
In [ ]: if True: # set to False to skip and go to next parts of code
        y_predicted = vgg_model.predict(test_generator)
        pred = vgg_model.evaluate(test_generator)
```

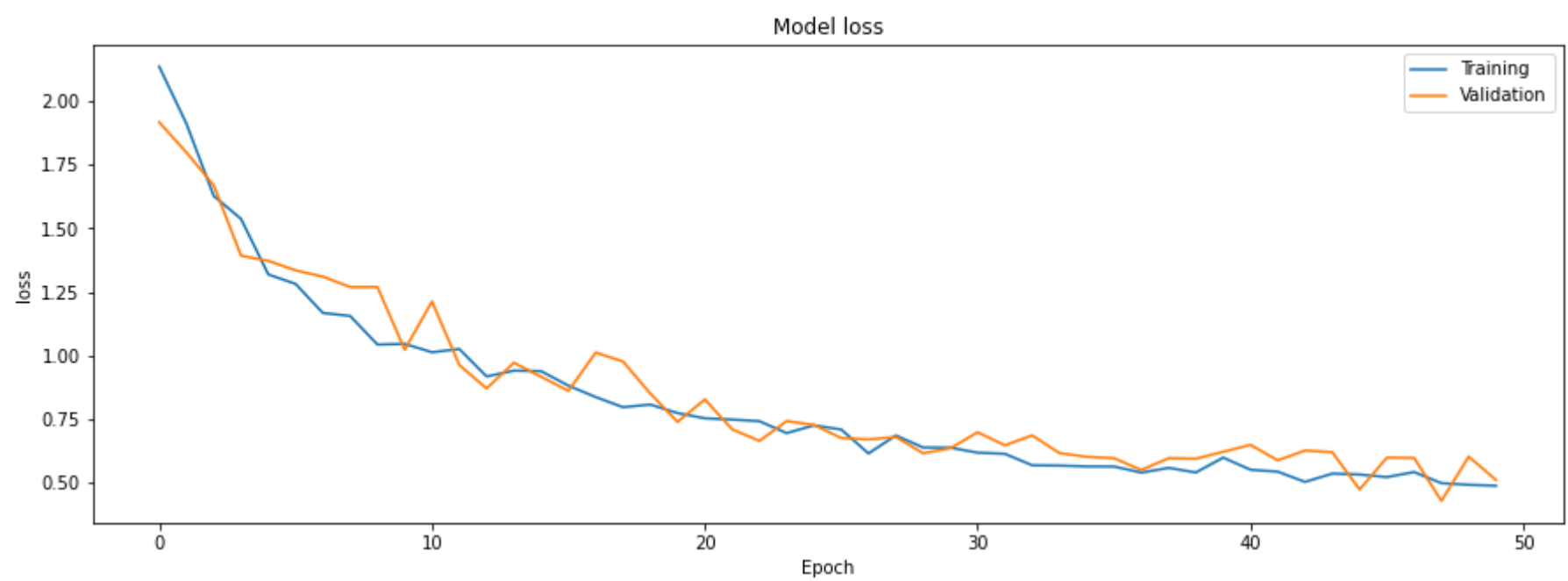
4/4 [=====] - 1s 189ms/step - loss: 0.6202 - accuracy: 0.8200

```
In [ ]: if True: # set to False to skip and go to next parts of code
        report_results(vgg_model, np.array(y_tests[LABEL]), y_predicted)
        plotModelHistory(history_vgg)
```

Accuracy score: 0.82

	precision	recall	f1-score	support
Ak	0.89	0.85	0.87	20
Ala_Idris	0.88	0.70	0.78	20
Buzgulu	0.71	0.75	0.73	20
Dimnit	0.72	0.90	0.80	20
Nazli	0.95	0.90	0.92	20
accuracy			0.82	100
macro avg	0.83	0.82	0.82	100
weighted avg	0.83	0.82	0.82	100





The next model which is ofcours better that the previous one is ResNet50

```
In [ ]: if True: # set to False to skip and go to next parts of code
    from keras.applications.resnet import ResNet50
    resnet50 = ResNet50(input_shape=image_shape, include_top=False, weights='imagenet')

    for layer in resnet50.layers:
        layer.trainable = False

    x = GlobalAveragePooling2D()(resnet50.output)
    predictions = Dense(5, activation='softmax')(x)

    resnet_model = Model(inputs = resnet50.input, outputs = predictions)

    resnet_model.compile(loss='categorical_crossentropy', optimizer="adam", metrics=['accuracy'])

    history_resnet50 = resnet_model.fit(
        train_generator,
        validation_data=val_generator,
        epochs=50,
        verbose=2,
        callbacks=callbacks
    )
```

Epoch 1/50
10/10 - 13s - loss: 1.8190 - accuracy: 0.1719 - val_loss: 1.6021 - val_accuracy: 0.2000 - 13s/epoch - 1s/step
Epoch 2/50
10/10 - 8s - loss: 1.5404 - accuracy: 0.3125 - val_loss: 1.3995 - val_accuracy: 0.4000 - 8s/epoch - 808ms/step
Epoch 3/50
10/10 - 8s - loss: 1.3757 - accuracy: 0.4250 - val_loss: 1.3874 - val_accuracy: 0.4375 - 8s/epoch - 815ms/step
Epoch 4/50
10/10 - 8s - loss: 1.2297 - accuracy: 0.5781 - val_loss: 1.2921 - val_accuracy: 0.5250 - 8s/epoch - 808ms/step
Epoch 5/50
10/10 - 8s - loss: 1.1470 - accuracy: 0.6000 - val_loss: 1.1848 - val_accuracy: 0.5500 - 8s/epoch - 803ms/step
Epoch 6/50
10/10 - 8s - loss: 1.0766 - accuracy: 0.6156 - val_loss: 1.0966 - val_accuracy: 0.6000 - 8s/epoch - 804ms/step
Epoch 7/50
10/10 - 9s - loss: 1.0464 - accuracy: 0.6187 - val_loss: 1.0147 - val_accuracy: 0.6750 - 9s/epoch - 883ms/step
Epoch 8/50
10/10 - 8s - loss: 0.9734 - accuracy: 0.6844 - val_loss: 1.0148 - val_accuracy: 0.6625 - 8s/epoch - 807ms/step
Epoch 9/50
10/10 - 8s - loss: 0.9260 - accuracy: 0.7063 - val_loss: 0.9712 - val_accuracy: 0.6250 - 8s/epoch - 805ms/step
Epoch 10/50
10/10 - 8s - loss: 0.9052 - accuracy: 0.6906 - val_loss: 0.9197 - val_accuracy: 0.7000 - 8s/epoch - 814ms/step
Epoch 11/50
10/10 - 8s - loss: 0.8556 - accuracy: 0.7375 - val_loss: 0.9526 - val_accuracy: 0.6250 - 8s/epoch - 812ms/step
Epoch 12/50
10/10 - 8s - loss: 0.8013 - accuracy: 0.7563 - val_loss: 0.9013 - val_accuracy: 0.7000 - 8s/epoch - 808ms/step
Epoch 13/50
10/10 - 8s - loss: 0.7953 - accuracy: 0.7750 - val_loss: 0.8913 - val_accuracy: 0.6750 - 8s/epoch - 808ms/step
Epoch 14/50
10/10 - 8s - loss: 0.7395 - accuracy: 0.8000 - val_loss: 0.8332 - val_accuracy: 0.7250 - 8s/epoch - 817ms/step
Epoch 15/50
10/10 - 8s - loss: 0.7842 - accuracy: 0.7375 - val_loss: 0.8357 - val_accuracy: 0.7750 - 8s/epoch - 818ms/step
Epoch 16/50
10/10 - 8s - loss: 0.7189 - accuracy: 0.7906 - val_loss: 0.7433 - val_accuracy: 0.7750 - 8s/epoch - 806ms/step
Epoch 17/50
10/10 - 8s - loss: 0.7005 - accuracy: 0.7844 - val_loss: 0.7974 - val_accuracy: 0.6750 - 8s/epoch - 807ms/step
Epoch 18/50
10/10 - 9s - loss: 0.7223 - accuracy: 0.7688 - val_loss: 0.8373 - val_accuracy: 0.7625 - 9s/epoch - 927ms/step
Epoch 19/50
10/10 - 8s - loss: 0.6506 - accuracy: 0.7937 - val_loss: 0.7048 - val_accuracy: 0.7875 - 8s/epoch - 804ms/step
Epoch 20/50
10/10 - 8s - loss: 0.6700 - accuracy: 0.8125 - val_loss: 0.7221 - val_accuracy: 0.7625 - 8s/epoch - 809ms/step
Epoch 21/50
10/10 - 9s - loss: 0.6147 - accuracy: 0.8219 - val_loss: 0.6774 - val_accuracy: 0.7750 - 9s/epoch - 856ms/step
Epoch 22/50
10/10 - 8s - loss: 0.6268 - accuracy: 0.8031 - val_loss: 0.7304 - val_accuracy: 0.7500 - 8s/epoch - 807ms/step
Epoch 23/50
10/10 - 8s - loss: 0.6310 - accuracy: 0.8438 - val_loss: 0.6891 - val_accuracy: 0.7625 - 8s/epoch - 806ms/step
Epoch 24/50
10/10 - 8s - loss: 0.5963 - accuracy: 0.8313 - val_loss: 0.6834 - val_accuracy: 0.7750 - 8s/epoch - 814ms/step
Epoch 25/50
10/10 - 8s - loss: 0.5722 - accuracy: 0.8250 - val_loss: 0.7585 - val_accuracy: 0.7625 - 8s/epoch - 812ms/step
Epoch 26/50
10/10 - 9s - loss: 0.5685 - accuracy: 0.8219 - val_loss: 0.6685 - val_accuracy: 0.7750 - 9s/epoch - 858ms/step
Epoch 27/50
10/10 - 9s - loss: 0.5937 - accuracy: 0.8344 - val_loss: 0.6206 - val_accuracy: 0.7875 - 9s/epoch - 854ms/step
Epoch 28/50
10/10 - 10s - loss: 0.5724 - accuracy: 0.8250 - val_loss: 0.6189 - val_accuracy: 0.8500 - 10s/epoch - 968ms/step
Epoch 29/50
10/10 - 8s - loss: 0.5555 - accuracy: 0.8406 - val_loss: 0.7047 - val_accuracy: 0.7250 - 8s/epoch - 811ms/step
Epoch 30/50
10/10 - 8s - loss: 0.5470 - accuracy: 0.8500 - val_loss: 0.6297 - val_accuracy: 0.8250 - 8s/epoch - 814ms/step
Epoch 31/50
10/10 - 8s - loss: 0.5379 - accuracy: 0.8156 - val_loss: 0.6456 - val_accuracy: 0.8000 - 8s/epoch - 811ms/step
Epoch 32/50
10/10 - 8s - loss: 0.5307 - accuracy: 0.8438 - val_loss: 0.7439 - val_accuracy: 0.7625 - 8s/epoch - 812ms/step
Epoch 33/50
10/10 - 9s - loss: 0.5129 - accuracy: 0.8531 - val_loss: 0.4671 - val_accuracy: 0.9000 - 9s/epoch - 855ms/step
Epoch 34/50
10/10 - 8s - loss: 0.4975 - accuracy: 0.8500 - val_loss: 0.6316 - val_accuracy: 0.8250 - 8s/epoch - 808ms/step
Epoch 35/50
10/10 - 8s - loss: 0.5125 - accuracy: 0.8500 - val_loss: 0.6246 - val_accuracy: 0.7750 - 8s/epoch - 807ms/step
Epoch 36/50
10/10 - 8s - loss: 0.4923 - accuracy: 0.8406 - val_loss: 0.5835 - val_accuracy: 0.7875 - 8s/epoch - 811ms/step
Epoch 37/50
10/10 - 8s - loss: 0.4883 - accuracy: 0.8625 - val_loss: 0.6803 - val_accuracy: 0.7500 - 8s/epoch - 808ms/step
Epoch 38/50
10/10 - 8s - loss: 0.4617 - accuracy: 0.8781 - val_loss: 0.5582 - val_accuracy: 0.7875 - 8s/epoch - 806ms/step
Epoch 39/50
10/10 - 9s - loss: 0.5035 - accuracy: 0.8531 - val_loss: 0.6980 - val_accuracy: 0.7500 - 9s/epoch - 930ms/step
Epoch 40/50
10/10 - 8s - loss: 0.4945 - accuracy: 0.8594 - val_loss: 0.5754 - val_accuracy: 0.8250 - 8s/epoch - 812ms/step
Epoch 41/50
10/10 - 8s - loss: 0.4610 - accuracy: 0.8813 - val_loss: 0.5662 - val_accuracy: 0.8125 - 8s/epoch - 808ms/step
Epoch 42/50
10/10 - 8s - loss: 0.5004 - accuracy: 0.8562 - val_loss: 0.6758 - val_accuracy: 0.8000 - 8s/epoch - 806ms/step
Epoch 43/50
10/10 - 8s - loss: 0.4514 - accuracy: 0.8687 - val_loss: 0.6674 - val_accuracy: 0.7125 - 8s/epoch - 806ms/step
Epoch 44/50
10/10 - 8s - loss: 0.4484 - accuracy: 0.8719 - val_loss: 0.6619 - val_accuracy: 0.8000 - 8s/epoch - 809ms/step
Epoch 45/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step
Epoch 46/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step
Epoch 47/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step
Epoch 48/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step
Epoch 49/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step
Epoch 50/50
10/10 - 8s - loss: 0.4518 - accuracy: 0.8656 - val_loss: 0.5257 - val_accuracy: 0.8500 - 8s/epoch - 814ms/step

Epoch 47/50

10/10 - 14s - loss: 0.4346 - accuracy: 0.8781 - val_loss: 0.5772 - val_accuracy: 0.8375 - 14s/epoch - 1s/step

Epoch 48/50

10/10 - 16s - loss: 0.4435 - accuracy: 0.8469 - val_loss: 0.6049 - val_accuracy: 0.7750 - 16s/epoch - 2s/step

Epoch 49/50

10/10 - 9s - loss: 0.4678 - accuracy: 0.8625 - val_loss: 0.5979 - val_accuracy: 0.8125 - 9s/epoch - 912ms/step

Epoch 50/50

10/10 - 16s - loss: 0.4223 - accuracy: 0.8844 - val_loss: 0.5487 - val_accuracy: 0.8250 - 16s/epoch - 2s/step

Now Evaluating

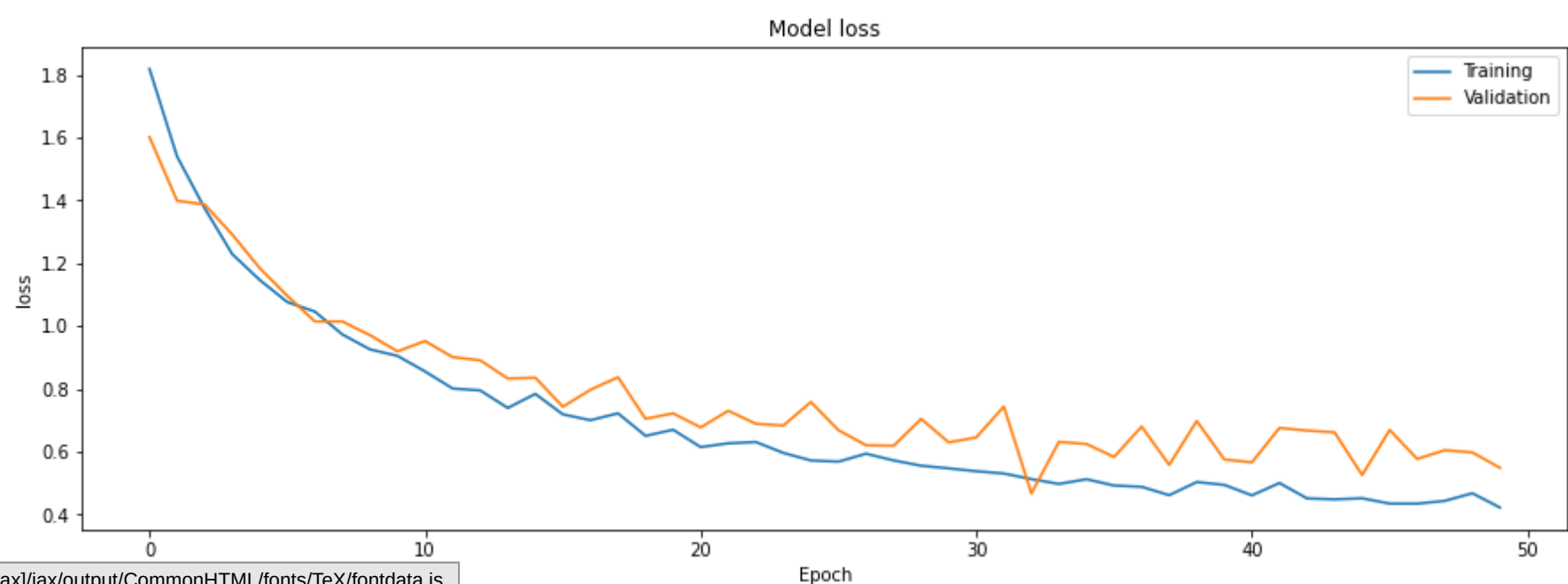
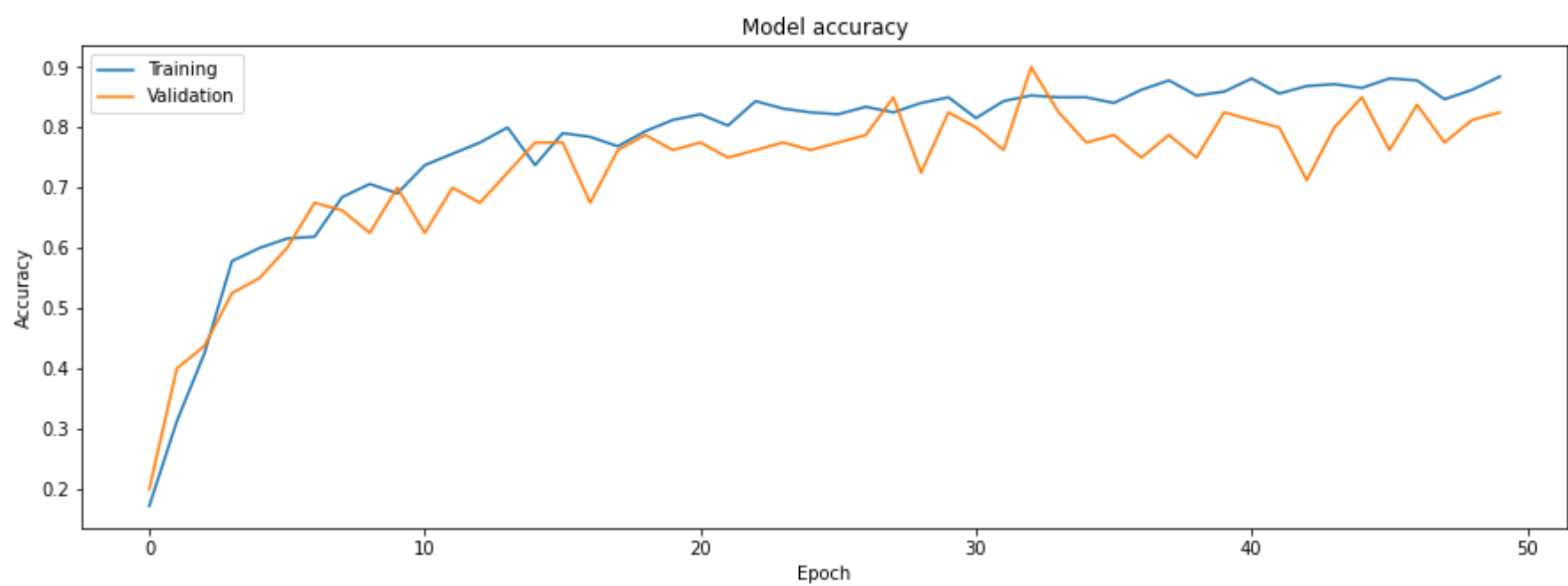
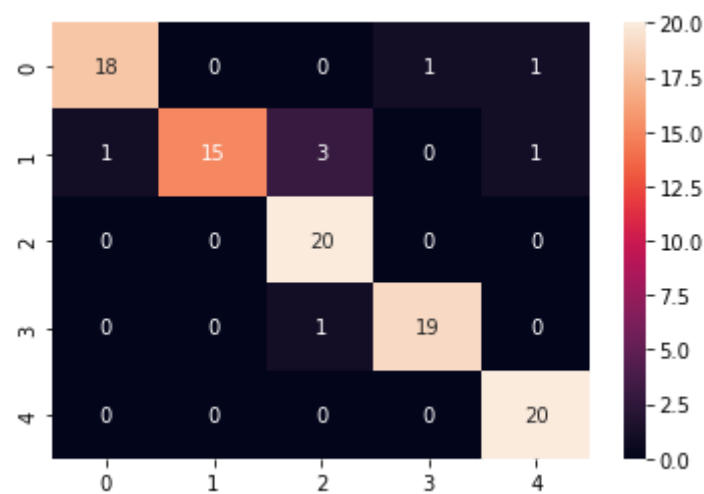
```
In [ ]: if True: # set to False to skip and go to next parts of code
        y_predicted = resnet_model.predict(test_generator)
        _ = resnet_model.evaluate(test_generator)
```

4/4 [=====] - 1s 182ms/step - loss: 0.3365 - accuracy: 0.8800

```
In [ ]: if True: # set to False to skip and go to next parts of code
        report_results(resnet_model, np.array(y_tests[LABEL]), y_predicted)
        plotModelHistory(history_resnet50)
```

Accuracy score: 0.92

	precision	recall	f1-score	support
Ak	0.95	0.90	0.92	20
Ala_Idris	1.00	0.75	0.86	20
Buzgulu	0.83	1.00	0.91	20
Dimnit	0.95	0.95	0.95	20
Nazli	0.91	1.00	0.95	20
accuracy			0.92	100
macro avg	0.93	0.92	0.92	100
weighted avg	0.93	0.92	0.92	100



The next model which turns out to be the best is EfficientNetB3 which takes more complexity to build

```
In [ ]: from tensorflow.keras.optimizers import Adam, Adamax
from keras.layers import BatchNormalization, Dropout
from keras import regularizers
if True: # set to False to skip and go to next parts of code
    model_name = 'EfficientNetB3'
    base_model = tf.keras.applications.efficientnet.EfficientNetB3(weights="imagenet", pooling='max', include_top=False,
    base_model.trainable = True

    x = base_model.output
    x = BatchNormalization(axis=-1, momentum=0.99, epsilon=0.001)(x)
    x = Dense(256, kernel_regularizer = regularizers.l2(l = 0.016),activity_regularizer=regularizers.l1(0.006),
              bias_regularizer=regularizers.l1(0.006) ,activation='relu')(x)
    x = Dropout(rate=.4, seed=123)(x)
    output = Dense(5, activation='softmax')(x)
    EfficientNet_model = Model(inputs=base_model.input, outputs=output)
    lr = 0.001
    EfficientNet_model.compile(Adamax(learning_rate=lr), loss='categorical_crossentropy', metrics=['accuracy'])

    epochs = 50

    history = EfficientNet_model.fit(x=train_generator, epochs=epochs, verbose=1, validation_data=val_generator,
                                    validation_steps=None, shuffle=False, initial_epoch=0, callbacks = callbacks)
```

```
Epoch 1/50
10/10 [=====] - 41s 2s/step - loss: 9.5012 - accuracy: 0.4344 - val_loss: 11.3344 - val_accu
racy: 0.2875
Epoch 2/50
10/10 [=====] - 13s 1s/step - loss: 8.4377 - accuracy: 0.6938 - val_loss: 11.8021 - val_accu
racy: 0.3750
Epoch 3/50
10/10 [=====] - 13s 1s/step - loss: 8.1323 - accuracy: 0.7344 - val_loss: 11.1120 - val_accu
racy: 0.4375
Epoch 4/50
10/10 [=====] - 13s 1s/step - loss: 7.6528 - accuracy: 0.8125 - val_loss: 10.6090 - val_accu
racy: 0.4000
Epoch 5/50
10/10 [=====] - 12s 1s/step - loss: 7.3907 - accuracy: 0.8719 - val_loss: 10.1761 - val_accu
racy: 0.3750
Epoch 6/50
10/10 [=====] - 12s 1s/step - loss: 7.1000 - accuracy: 0.8719 - val_loss: 8.9470 - val_accu
racy: 0.4500
Epoch 7/50
10/10 [=====] - 12s 1s/step - loss: 6.8389 - accuracy: 0.8969 - val_loss: 8.3635 - val_accu
racy: 0.5500
Epoch 8/50
10/10 [=====] - 13s 1s/step - loss: 6.6926 - accuracy: 0.8813 - val_loss: 8.0647 - val_accu
racy: 0.6000
Epoch 9/50
10/10 [=====] - 14s 1s/step - loss: 6.4250 - accuracy: 0.8906 - val_loss: 7.1421 - val_accu
racy: 0.7000
Epoch 10/50
10/10 [=====] - 13s 1s/step - loss: 6.1764 - accuracy: 0.8969 - val_loss: 6.9342 - val_accu
racy: 0.7375
Epoch 11/50
10/10 [=====] - 12s 1s/step - loss: 5.9969 - accuracy: 0.9375 - val_loss: 7.0275 - val_accu
racy: 0.6500
Epoch 12/50
10/10 [=====] - 13s 1s/step - loss: 5.7936 - accuracy: 0.9187 - val_loss: 6.6884 - val_accu
racy: 0.7250
Epoch 13/50
10/10 [=====] - 12s 1s/step - loss: 5.5732 - accuracy: 0.9344 - val_loss: 6.1783 - val_accu
racy: 0.8125
Epoch 14/50
10/10 [=====] - 12s 1s/step - loss: 5.3504 - accuracy: 0.9563 - val_loss: 5.8598 - val_accu
racy: 0.8250
Epoch 15/50
10/10 [=====] - 12s 1s/step - loss: 5.1948 - accuracy: 0.9469 - val_loss: 5.9757 - val_accu
racy: 0.7875
Epoch 16/50
10/10 [=====] - 13s 1s/step - loss: 5.0103 - accuracy: 0.9688 - val_loss: 5.4291 - val_accu
racy: 0.8625
Epoch 17/50
10/10 [=====] - 13s 1s/step - loss: 4.8371 - accuracy: 0.9781 - val_loss: 5.1642 - val_accu
racy: 0.9000
Epoch 18/50
10/10 [=====] - 12s 1s/step - loss: 4.6706 - accuracy: 0.9875 - val_loss: 4.9379 - val_accu
racy: 0.8875
Epoch 19/50
10/10 [=====] - 13s 1s/step - loss: 4.5623 - accuracy: 0.9656 - val_loss: 4.8602 - val_accu
racy: 0.9125
Epoch 20/50
10/10 [=====] - 12s 1s/step - loss: 4.4046 - accuracy: 0.9781 - val_loss: 4.6261 - val_accu
racy: 0.9250
Epoch 21/50
10/10 [=====] - 12s 1s/step - loss: 4.2845 - accuracy: 0.9688 - val_loss: 4.3858 - val_accu
racy: 0.9250
Epoch 22/50
10/10 [=====] - 12s 1s/step - loss: 4.1296 - accuracy: 0.9812 - val_loss: 4.2839 - val_accu
racy: 0.9250
Epoch 23/50
10/10 [=====] - 13s 1s/step - loss: 4.0187 - accuracy: 0.9781 - val_loss: 4.1595 - val_accu
racy: 0.9250
Epoch 24/50
10/10 [=====] - 13s 1s/step - loss: 3.8860 - accuracy: 0.9781 - val_loss: 3.9974 - val_accu
racy: 0.9625
Epoch 25/50
10/10 [=====] - 13s 1s/step - loss: 3.7811 - accuracy: 0.9844 - val_loss: 3.9102 - val_accu
racy: 0.9500
Epoch 26/50
10/10 [=====] - 13s 1s/step - loss: 3.6674 - accuracy: 0.9844 - val_loss: 3.6954 - val_accu
racy: 0.9625
Epoch 27/50
10/10 [=====] - 12s 1s/step - loss: 3.5676 - accuracy: 0.9844 - val_loss: 3.6642 - val_accu
racy: 0.9500
Epoch 28/50
10/10 [=====] - 12s 1s/step - loss: 3.4464 - accuracy: 0.9875 - val_loss: 3.5438 - val_accu
racy: 0.9625
Epoch 29/50
10/10 [=====] - 12s 1s/step - loss: 3.3358 - accuracy: 0.9875 - val_loss: 3.3802 - val_accu
racy: 0.9625
Epoch 30/50
10/10 [=====] - 12s 1s/step - loss: 3.2403 - accuracy: 0.9875 - val_loss: 3.2654 - val_accu
racy: 0.9625
Epoch 31/50
10/10 [=====] - 16s 2s/step - loss: 3.1434 - accuracy: 0.9906 - val_loss: 3.1543 - val_accu
racy: 0.9625
```

Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js

acy: 0.9500
Epoch 32/50
10/10 [=====] - 12s 1s/step - loss: 3.0796 - accuracy: 0.9719 - val_loss: 3.1791 - val_accu
acy: 0.9375
Epoch 33/50
10/10 [=====] - 12s 1s/step - loss: 2.9577 - accuracy: 0.9875 - val_loss: 2.9974 - val_accu
acy: 0.9500
Epoch 34/50
10/10 [=====] - 12s 1s/step - loss: 2.8758 - accuracy: 0.9844 - val_loss: 2.8676 - val_accu
acy: 0.9625
Epoch 35/50
10/10 [=====] - 13s 1s/step - loss: 2.7852 - accuracy: 0.9937 - val_loss: 2.8273 - val_accu
acy: 0.9625
Epoch 36/50
10/10 [=====] - 13s 1s/step - loss: 2.7104 - accuracy: 0.9875 - val_loss: 2.7380 - val_accu
acy: 0.9375
Epoch 37/50
10/10 [=====] - 13s 1s/step - loss: 2.6272 - accuracy: 0.9937 - val_loss: 2.6805 - val_accu
acy: 0.9375
Epoch 38/50
10/10 [=====] - 13s 1s/step - loss: 2.5524 - accuracy: 0.9937 - val_loss: 2.5831 - val_accu
acy: 0.9375
Epoch 39/50
10/10 [=====] - 12s 1s/step - loss: 2.4837 - accuracy: 0.9906 - val_loss: 2.4805 - val_accu
acy: 0.9500
Epoch 40/50
10/10 [=====] - 13s 1s/step - loss: 2.4123 - accuracy: 0.9844 - val_loss: 2.4131 - val_accu
acy: 0.9750
Epoch 41/50
10/10 [=====] - 12s 1s/step - loss: 2.3191 - accuracy: 1.0000 - val_loss: 2.3700 - val_accu
acy: 0.9625
Epoch 42/50
10/10 [=====] - 12s 1s/step - loss: 2.2519 - accuracy: 0.9969 - val_loss: 2.2730 - val_accu
acy: 0.9875
Epoch 43/50
10/10 [=====] - 12s 1s/step - loss: 2.1721 - accuracy: 1.0000 - val_loss: 2.1785 - val_accu
acy: 0.9625
Epoch 44/50
10/10 [=====] - 12s 1s/step - loss: 2.1228 - accuracy: 0.9937 - val_loss: 2.1321 - val_accu
acy: 0.9750
Epoch 45/50
10/10 [=====] - 12s 1s/step - loss: 2.0813 - accuracy: 0.9906 - val_loss: 2.0696 - val_accu
acy: 0.9750
Epoch 46/50
10/10 [=====] - 13s 1s/step - loss: 2.0039 - accuracy: 0.9937 - val_loss: 1.9999 - val_accu
acy: 0.9750
Epoch 47/50
10/10 [=====] - 11s 1s/step - loss: 1.9394 - accuracy: 0.9937 - val_loss: 2.0070 - val_accu
acy: 0.9625
Epoch 48/50
10/10 [=====] - 13s 1s/step - loss: 1.9210 - accuracy: 0.9781 - val_loss: 1.9256 - val_accu
acy: 0.9625
Epoch 49/50
10/10 [=====] - 12s 1s/step - loss: 1.8467 - accuracy: 0.9969 - val_loss: 1.9274 - val_accu
acy: 0.9375
Epoch 50/50
10/10 [=====] - 13s 1s/step - loss: 1.7787 - accuracy: 0.9969 - val_loss: 1.8588 - val_accu
acy: 0.9625

Evaluating

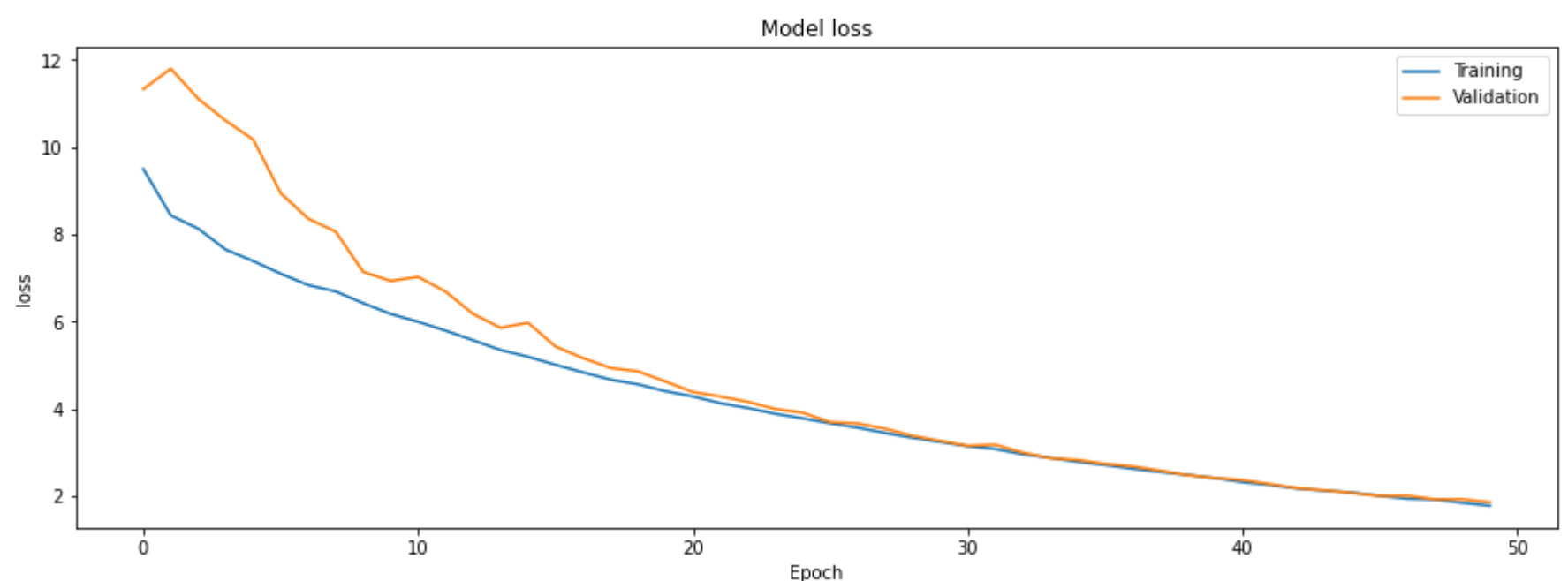
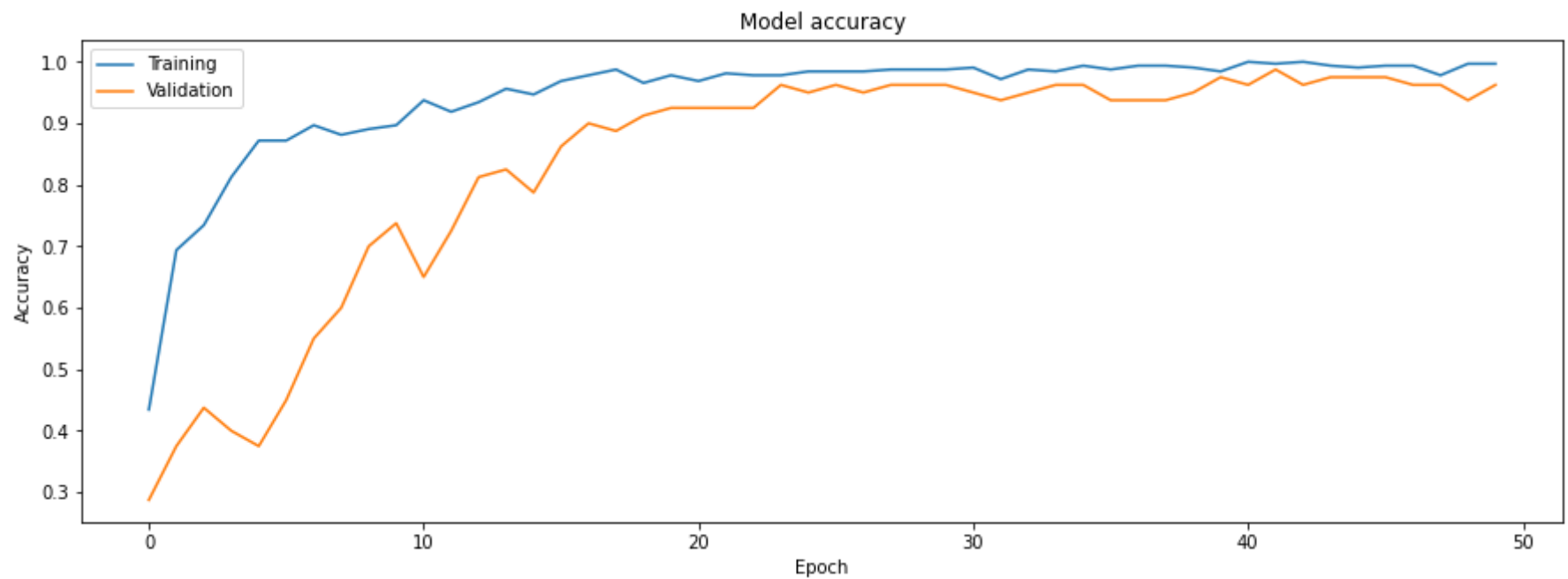
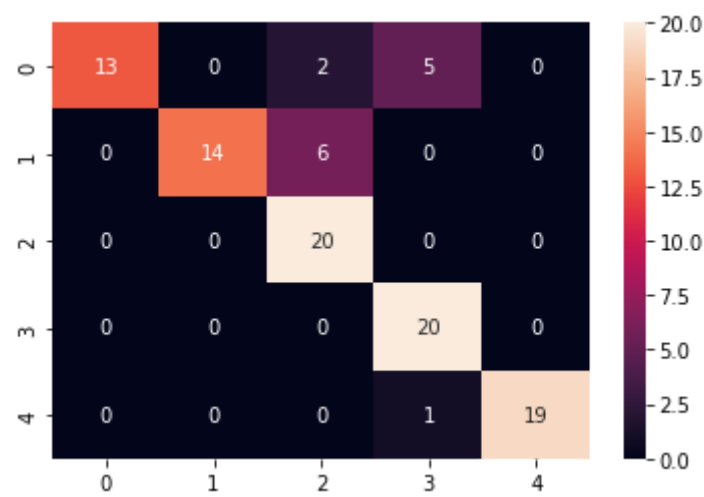
```
In [ ]: if True: # set to False to skip and go to next parts of code
        y_predicted = EfficientNet_model.predict(test_generator)
        _ = EfficientNet_model.evaluate(test_generator)
```

4/4 [=====] - 1s 179ms/step - loss: 2.1466 - accuracy: 0.8600

```
In [ ]: if True: # set to False to skip and go to next parts of code
        report_results(EfficientNet_model, np.array(y_tests[LABEL]), y_predicted)
        plotModelHistory(history)
```

Accuracy score: 0.86

	precision	recall	f1-score	support
Ak	1.00	0.65	0.79	20
Ala_Idris	1.00	0.70	0.82	20
Buzgulu	0.71	1.00	0.83	20
Dimnit	0.77	1.00	0.87	20
Nazli	1.00	0.95	0.97	20
accuracy			0.86	100
macro avg	0.90	0.86	0.86	100
weighted avg	0.90	0.86	0.86	100



Now we do a 10fold-cross-validation with our best model

```
In [ ]: new_x_trains = pd.concat([x_trains, x_validations])
new_y_trains = pd.concat([y_trains, y_validations])

new_df = pd.concat([new_x_trains, new_y_trains], axis=1)
new_df = new_df.sample(frac=1)

new_x_trains = new_df[PATH]
new_y_trains = new_df[LABEL]

kf_accuracies = []
kf_losses = []

for i in range(10):
    print(f"=====fold {i+1}:=====")
    kf_x_valid = new_x_trains.iloc[i*40:i*40+40]
    kf_x_train = pd.concat([new_x_trains.iloc[0:i*40], new_x_trains.iloc[i*40+40:]]
    kf_y_valid = new_y_trains.iloc[i*40:i*40+40]
    kf_y_train = pd.concat([new_y_trains.iloc[0:i*40], new_y_trains.iloc[i*40+40:]]

    kf_train_data = pd.concat([kf_x_train, kf_y_train], axis=1)
    kf_valid_data = pd.concat([kf_x_valid, kf_y_valid], axis=1)

    kf_train_generator = data_generator.flow_from_dataframe(
        kf_train_data,
        x_col=PATH,
        y_col=LABEL,
        target_size=image_size,
        batch_size=batch_size,
        class_mode='categorical',
        shuffle=True)
```

```
        shuffle=True,
    )

kf_valid_generator = test_data_generator.flow_from_dataframe(
    kf_valid_data,
    x_col=PATH,
    y_col=LABEL,
    target_size=image_size,
    batch_size=32,
    class_mode="categorical",
    shuffle=False,
)

base_model=tf.keras.applications.efficientnet.EfficientNetB3(weights="imagenet", pooling='max', include_top=False)
base_model.trainable = True
x = base_model.output
x = BatchNormalization(axis=-1, momentum=0.99, epsilon=0.001)(x)
x = Dense(256, kernel_regularizer = regularizers.l2(l = 0.016),activity_regularizer=regularizers.l1(0.006),
        bias_regularizer=regularizers.l1(0.006) ,activation='relu')(x)
x = Dropout(rate=0.4, seed=123)(x)
output = Dense(5, activation='softmax')(x)
model = Model(inputs=base_model.input, outputs=output)
lr = 0.001
model.compile(Adamax(learning_rate=lr), loss='categorical_crossentropy', metrics=['accuracy'])

epochs = 40

history = model.fit(x=kf_train_generator, epochs=epochs, verbose=1,
        validation_steps=None, shuffle=False, initial_epoch=0, callbacks=callbacks)

valid_pred = model.evaluate(kf_valid_generator, verbose=0)
test_pred = model.evaluate(test_generator, verbose=0)

print("result on validation:", valid_pred[1])
print("result on test:", test_pred[1])

kf accuracies.append(valid_pred[1] * 100)
kf_losses.append(valid_pred[0])
```

```
=====fold 1:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.6404 - accuracy: 0.3833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 22s 749ms/step - loss: 9.6404 - accuracy: 0.3833
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.6849 - accuracy: 0.6556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 9s 751ms/step - loss: 8.6849 - accuracy: 0.6556
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.2012 - accuracy: 0.7111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 8.2012 - accuracy: 0.7111
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.8066 - accuracy: 0.7778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 809ms/step - loss: 7.8066 - accuracy: 0.7778
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.5298 - accuracy: 0.8194WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 12s 952ms/step - loss: 7.5298 - accuracy: 0.8194
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.2864 - accuracy: 0.8306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 7.2864 - accuracy: 0.8306
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.9782 - accuracy: 0.8750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 753ms/step - loss: 6.9782 - accuracy: 0.8750
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7940 - accuracy: 0.8722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.7940 - accuracy: 0.8722
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.5986 - accuracy: 0.8917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 6.5986 - accuracy: 0.8917
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.3909 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 6.3909 - accuracy: 0.9111
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.1569 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 6.1569 - accuracy: 0.9417
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0156 - accuracy: 0.9278WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 814ms/step - loss: 6.0156 - accuracy: 0.9278
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.8302 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 786ms/step - loss: 5.8302 - accuracy: 0.9389
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.7199 - accuracy: 0.9222WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 799ms/step - loss: 5.7199 - accuracy: 0.9222
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.5214 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.5214 - accuracy: 0.9611
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.3750 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 5.3750 - accuracy: 0.9639
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.3022 - accuracy: 0.9361WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 5.3022 - accuracy: 0.9361
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.1336 - accuracy: 0.9500WARNING:tensorflow:Can save best mo
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js, skipping.
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WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.1336 - accuracy: 0.9500
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 5.0135 - accuracy: 0.9444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.0135 - accuracy: 0.9444
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.8520 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 4.8520 - accuracy: 0.9722
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.7312 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.7312 - accuracy: 0.9750
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.6293 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 871ms/step - loss: 4.6293 - accuracy: 0.9750
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.5202 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.5202 - accuracy: 0.9778
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.4107 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.4107 - accuracy: 0.9750
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.3159 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.3159 - accuracy: 0.9806
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.2240 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 4.2240 - accuracy: 0.9778
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.1048 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.1048 - accuracy: 0.9944
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 4.0383 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 4.0383 - accuracy: 0.9611
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.9030 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.9030 - accuracy: 0.9917
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.8609 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 3.8609 - accuracy: 0.9694
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.7868 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 870ms/step - loss: 3.7868 - accuracy: 0.9750
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.7123 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.7123 - accuracy: 0.9833
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.6120 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 3.6120 - accuracy: 0.9833
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.5714 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.5714 - accuracy: 0.9722
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.4756 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 3.4756 - accuracy: 0.9806
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.3741 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - 10s 764ms/step - loss: 3.3741 - accuracy: 0.9944
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Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.2977 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.2977 - accuracy: 0.9889
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.2442 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 3.2442 - accuracy: 0.9944
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.1926 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.1926 - accuracy: 0.9861
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 3.1427 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 820ms/step - loss: 3.1427 - accuracy: 0.9889
result on validation: 0.9005
result on test: 0.9113
=====fold 2:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.5874 - accuracy: 0.3833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 23s 765ms/step - loss: 9.5874 - accuracy: 0.3833
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.4982 - accuracy: 0.6417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 8.4982 - accuracy: 0.6417
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.1947 - accuracy: 0.7417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 8.1947 - accuracy: 0.7417
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.6566 - accuracy: 0.8111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 773ms/step - loss: 7.6566 - accuracy: 0.8111
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.3639 - accuracy: 0.8611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 7.3639 - accuracy: 0.8611
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.0513 - accuracy: 0.8833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 868ms/step - loss: 7.0513 - accuracy: 0.8833
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.7829 - accuracy: 0.9083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 6.7829 - accuracy: 0.9083
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.5930 - accuracy: 0.9028WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 6.5930 - accuracy: 0.9028
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.3363 - accuracy: 0.9528WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 6.3363 - accuracy: 0.9528
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.1620 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 6.1620 - accuracy: 0.9417
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 5.9394 - accuracy: 0.9500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 5.9394 - accuracy: 0.9500
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 5.8384 - accuracy: 0.9250WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 5.8384 - accuracy: 0.9250
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.6210 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 5.6210 - accuracy: 0.9417
Epoch 14/40
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - ETA: 0s - loss: 5.5496 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
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del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 5.5496 - accuracy: 0.9417
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.3726 - accuracy: 0.9444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 877ms/step - loss: 5.3726 - accuracy: 0.9444
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.2265 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 5.2265 - accuracy: 0.9556
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.0620 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 5.0620 - accuracy: 0.9806
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 4.9067 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.9067 - accuracy: 0.9639
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.8150 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.8150 - accuracy: 0.9722
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.6779 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 4.6779 - accuracy: 0.9750
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.5657 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.5657 - accuracy: 0.9861
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.4738 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 774ms/step - loss: 4.4738 - accuracy: 0.9833
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.3549 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 800ms/step - loss: 4.3549 - accuracy: 0.9806
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.2563 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 780ms/step - loss: 4.2563 - accuracy: 0.9750
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.1364 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.1364 - accuracy: 0.9944
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.0766 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 4.0766 - accuracy: 0.9750
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 3.9612 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.9612 - accuracy: 0.9917
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.8627 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.8627 - accuracy: 0.9889
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.7731 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 775ms/step - loss: 3.7731 - accuracy: 0.9889
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.6771 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.6771 - accuracy: 0.9917
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.6221 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.6221 - accuracy: 0.9694
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.5320 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js model only with val_loss available, skipping.
```



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12/12 [=====] - 11s 882ms/step - loss: 3.5320 - accuracy: 0.9889
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.4582 - accuracy: 1.0000WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 3.4582 - accuracy: 1.0000
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.3871 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 775ms/step - loss: 3.3871 - accuracy: 0.9806
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.3193 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 774ms/step - loss: 3.3193 - accuracy: 0.9833
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.2308 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 3.2308 - accuracy: 0.9917
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.1643 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.1643 - accuracy: 0.9806
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.0919 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.0919 - accuracy: 0.9889
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.0041 - accuracy: 1.0000WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.0041 - accuracy: 1.0000
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 2.9380 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 2.9380 - accuracy: 0.9944
result on validation: 0.9389
result on test: 0.9317
=====fold 3:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.5499 - accuracy: 0.3722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 22s 756ms/step - loss: 9.5499 - accuracy: 0.3722
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.7853 - accuracy: 0.5667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 8.7853 - accuracy: 0.5667
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.1321 - accuracy: 0.7056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 8.1321 - accuracy: 0.7056
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7410 - accuracy: 0.7972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 7.7410 - accuracy: 0.7972
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.4951 - accuracy: 0.8111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 7.4951 - accuracy: 0.8111
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.2722 - accuracy: 0.8333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 7.2722 - accuracy: 0.8333
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.8979 - accuracy: 0.8861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 6.8979 - accuracy: 0.8861
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7501 - accuracy: 0.9083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 789ms/step - loss: 6.7501 - accuracy: 0.9083
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.5204 - accuracy: 0.9250WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 6.5204 - accuracy: 0.9250
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12/12 [=====] - ETA: 0s - loss: 6.3939 - accuracy: 0.8889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 6.3939 - accuracy: 0.8889
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.2307 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.2307 - accuracy: 0.9111
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0869 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 6.0869 - accuracy: 0.9111
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.9048 - accuracy: 0.9194WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.9048 - accuracy: 0.9194
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.7302 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 5.7302 - accuracy: 0.9417
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.6024 - accuracy: 0.9306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.6024 - accuracy: 0.9306
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.4396 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 871ms/step - loss: 5.4396 - accuracy: 0.9611
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.2816 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 5.2816 - accuracy: 0.9639
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.1741 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 5.1741 - accuracy: 0.9556
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 5.0226 - accuracy: 0.9444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.0226 - accuracy: 0.9444
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.9122 - accuracy: 0.9528WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.9122 - accuracy: 0.9528
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.7756 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.7756 - accuracy: 0.9611
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.6772 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.6772 - accuracy: 0.9611
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.5137 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.5137 - accuracy: 0.9861
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.4212 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.4212 - accuracy: 0.9778
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.3269 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 859ms/step - loss: 4.3269 - accuracy: 0.9694
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.2421 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 4.2421 - accuracy: 0.9556
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.1896 - accuracy: 0.9500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.1896 - accuracy: 0.9500
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 4.0371 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js, skipping.
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WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 4.0371 - accuracy: 0.9889
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.9679 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.9679 - accuracy: 0.9694
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.8724 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.8724 - accuracy: 0.9722
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.7917 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 3.7917 - accuracy: 0.9778
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.6880 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 3.6880 - accuracy: 0.9944
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.6216 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.6216 - accuracy: 0.9806
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.5248 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 863ms/step - loss: 3.5248 - accuracy: 0.9889
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.4675 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 773ms/step - loss: 3.4675 - accuracy: 0.9722
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.4004 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.4004 - accuracy: 0.9806
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.3227 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 3.3227 - accuracy: 0.9861
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.2586 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 3.2586 - accuracy: 0.9833
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.2131 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 3.2131 - accuracy: 0.9833
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 3.1373 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.1373 - accuracy: 0.9778
result on validation: 0.9269
result on test: 0.9189
=====fold 4:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.4756 - accuracy: 0.4000WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 25s 755ms/step - loss: 9.4756 - accuracy: 0.4000
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.4882 - accuracy: 0.6444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 8.4882 - accuracy: 0.6444
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.0944 - accuracy: 0.7333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 8.0944 - accuracy: 0.7333
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7999 - accuracy: 0.7750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 7.7999 - accuracy: 0.7750
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.2640 - accuracy: 0.8667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - 10s 773ms/step - loss: 7.2640 - accuracy: 0.8667
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Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.1090 - accuracy: 0.8556WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 7.1090 - accuracy: 0.8556
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.8700 - accuracy: 0.8722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 6.8700 - accuracy: 0.8722
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7057 - accuracy: 0.8722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.7057 - accuracy: 0.8722
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.4520 - accuracy: 0.9028WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 871ms/step - loss: 6.4520 - accuracy: 0.9028
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.2353 - accuracy: 0.9111WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 6.2353 - accuracy: 0.9111
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.0817 - accuracy: 0.8972WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 774ms/step - loss: 6.0817 - accuracy: 0.8972
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 5.8764 - accuracy: 0.9222WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.8764 - accuracy: 0.9222
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.6765 - accuracy: 0.9417WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.6765 - accuracy: 0.9417
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.4929 - accuracy: 0.9444WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 5.4929 - accuracy: 0.9444
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.3351 - accuracy: 0.9639WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.3351 - accuracy: 0.9639
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.1876 - accuracy: 0.9639WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 5.1876 - accuracy: 0.9639
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.0277 - accuracy: 0.9583WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 5.0277 - accuracy: 0.9583
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 4.8780 - accuracy: 0.9750WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 866ms/step - loss: 4.8780 - accuracy: 0.9750
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.7663 - accuracy: 0.9611WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 4.7663 - accuracy: 0.9611
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.6370 - accuracy: 0.9722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 4.6370 - accuracy: 0.9722
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.5157 - accuracy: 0.9722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 4.5157 - accuracy: 0.9722
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.4183 - accuracy: 0.9639WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.4183 - accuracy: 0.9639
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.3226 - accuracy: 0.9528WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.3226 - accuracy: 0.9528
Epoch 24/40
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - ETA: 0s - loss: 4.2535 - accuracy: 0.9528WARNING:tensorflow:Can save best model only with val_loss available, skipping.

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del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.2535 - accuracy: 0.9528
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.1163 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.1163 - accuracy: 0.9667
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.0028 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 869ms/step - loss: 4.0028 - accuracy: 0.9750
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 3.8875 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.8875 - accuracy: 0.9833
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.7864 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.7864 - accuracy: 0.9889
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.7498 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.7498 - accuracy: 0.9722
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.6330 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.6330 - accuracy: 0.9861
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.5326 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.5326 - accuracy: 0.9861
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.4548 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.4548 - accuracy: 0.9889
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.3847 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 3.3847 - accuracy: 0.9944
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.2823 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.2823 - accuracy: 0.9889
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.2516 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 886ms/step - loss: 3.2516 - accuracy: 0.9750
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.1378 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.1378 - accuracy: 0.9944
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.0910 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.0910 - accuracy: 0.9833
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.0143 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.0143 - accuracy: 0.9833
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 2.9199 - accuracy: 0.9972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 2.9199 - accuracy: 0.9972
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 2.8699 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 2.8699 - accuracy: 0.9833
result on validation: 0.9572
result on test: 0.9433
=====fold 5:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.3954 - accuracy: 0.4167WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js model only with val_loss available, skipping.
```

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12/12 [=====] - 25s 869ms/step - loss: 9.3954 - accuracy: 0.4167
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.5617 - accuracy: 0.6528WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 8.5617 - accuracy: 0.6528
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.1945 - accuracy: 0.7417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 8.1945 - accuracy: 0.7417
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7339 - accuracy: 0.7972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 7.7339 - accuracy: 0.7972
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.5170 - accuracy: 0.8083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 7.5170 - accuracy: 0.8083
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.1645 - accuracy: 0.8583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 7.1645 - accuracy: 0.8583
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.9888 - accuracy: 0.8639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 6.9888 - accuracy: 0.8639
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.6511 - accuracy: 0.9167WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 6.6511 - accuracy: 0.9167
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.4201 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 6.4201 - accuracy: 0.9389
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.2284 - accuracy: 0.9167WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 870ms/step - loss: 6.2284 - accuracy: 0.9167
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.0443 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 6.0443 - accuracy: 0.9389
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 5.8728 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.8728 - accuracy: 0.9417
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.7318 - accuracy: 0.9361WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 5.7318 - accuracy: 0.9361
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.5690 - accuracy: 0.9472WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 5.5690 - accuracy: 0.9472
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.4341 - accuracy: 0.9306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 5.4341 - accuracy: 0.9306
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.2359 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 5.2359 - accuracy: 0.9667
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.0942 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.0942 - accuracy: 0.9667
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 4.9484 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 875ms/step - loss: 4.9484 - accuracy: 0.9694
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.8152 - accuracy: 0.9583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.8152 - accuracy: 0.9583
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12/12 [=====] - ETA: 0s - loss: 4.6604 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.6604 - accuracy: 0.9806
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.5753 - accuracy: 0.9583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 4.5753 - accuracy: 0.9583
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.4180 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 4.4180 - accuracy: 0.9889
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.2838 - accuracy: 0.9972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 4.2838 - accuracy: 0.9972
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.2143 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 4.2143 - accuracy: 0.9750
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.1001 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 4.1001 - accuracy: 0.9861
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.0033 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.0033 - accuracy: 0.9722
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 3.9122 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 876ms/step - loss: 3.9122 - accuracy: 0.9694
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.8032 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 3.8032 - accuracy: 0.9917
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.7377 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.7377 - accuracy: 0.9778
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.6343 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.6343 - accuracy: 0.9833
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.5411 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.5411 - accuracy: 0.9833
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.4481 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 3.4481 - accuracy: 0.9861
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.3982 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.3982 - accuracy: 0.9833
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.3120 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.3120 - accuracy: 0.9833
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.2206 - accuracy: 0.9972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 880ms/step - loss: 3.2206 - accuracy: 0.9972
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.1491 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.1491 - accuracy: 0.9833
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.0592 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.0592 - accuracy: 0.9944
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.0043 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js, skipping.
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WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 3.0043 - accuracy: 0.9833
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 2.9097 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 2.9097 - accuracy: 0.9917
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 2.8509 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 2.8509 - accuracy: 0.9889
result on validation: 0.9598
result on test: 0.9633
=====fold 6:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.7079 - accuracy: 0.3000WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 24s 772ms/step - loss: 9.7079 - accuracy: 0.3000
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.9180 - accuracy: 0.5028WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 794ms/step - loss: 8.9180 - accuracy: 0.5028
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.2566 - accuracy: 0.6556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 8.2566 - accuracy: 0.6556
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.9850 - accuracy: 0.7500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 7.9850 - accuracy: 0.7500
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.6604 - accuracy: 0.7611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 7.6604 - accuracy: 0.7611
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.3718 - accuracy: 0.8056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 7.3718 - accuracy: 0.8056
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 7.0157 - accuracy: 0.8444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 7.0157 - accuracy: 0.8444
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7705 - accuracy: 0.8806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 6.7705 - accuracy: 0.8806
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.6133 - accuracy: 0.8333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 6.6133 - accuracy: 0.8333
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.3547 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 878ms/step - loss: 6.3547 - accuracy: 0.9111
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.2287 - accuracy: 0.8944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.2287 - accuracy: 0.8944
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0172 - accuracy: 0.9083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 775ms/step - loss: 6.0172 - accuracy: 0.9083
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.8091 - accuracy: 0.9222WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 5.8091 - accuracy: 0.9222
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.6463 - accuracy: 0.9306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 5.6463 - accuracy: 0.9306
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.4509 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - 10s 772ms/step - loss: 5.4509 - accuracy: 0.9389
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Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.3181 - accuracy: 0.9500WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 5.3181 - accuracy: 0.9500
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.1654 - accuracy: 0.9528WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.1654 - accuracy: 0.9528
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.0534 - accuracy: 0.9583WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 878ms/step - loss: 5.0534 - accuracy: 0.9583
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.9270 - accuracy: 0.9667WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 4.9270 - accuracy: 0.9667
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.8062 - accuracy: 0.9694WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.8062 - accuracy: 0.9694
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.6950 - accuracy: 0.9639WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.6950 - accuracy: 0.9639
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.5649 - accuracy: 0.9750WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.5649 - accuracy: 0.9750
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.4453 - accuracy: 0.9806WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 4.4453 - accuracy: 0.9806
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.3405 - accuracy: 0.9722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.3405 - accuracy: 0.9722
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.2411 - accuracy: 0.9833WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.2411 - accuracy: 0.9833
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.1446 - accuracy: 0.9806WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 786ms/step - loss: 4.1446 - accuracy: 0.9806
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.0407 - accuracy: 0.9861WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 803ms/step - loss: 4.0407 - accuracy: 0.9861
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.9603 - accuracy: 0.9861WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.9603 - accuracy: 0.9861
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.8718 - accuracy: 0.9861WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.8718 - accuracy: 0.9861
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.7526 - accuracy: 0.9861WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.7526 - accuracy: 0.9861
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.6976 - accuracy: 0.9833WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.6976 - accuracy: 0.9833
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.6447 - accuracy: 0.9833WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.6447 - accuracy: 0.9833
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.5243 - accuracy: 0.9833WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.5243 - accuracy: 0.9833
Epoch 34/40
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - ETA: 0s - loss: 3.4764 - accuracy: 0.9833WARNING:tensorflow:Can save best model only with val_loss available, skipping.

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del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.4764 - accuracy: 0.9833
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.3921 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 881ms/step - loss: 3.3921 - accuracy: 0.9806
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.3376 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.3376 - accuracy: 0.9694
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.2633 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.2633 - accuracy: 0.9833
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.1843 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 3.1843 - accuracy: 0.9861
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.1000 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.1000 - accuracy: 0.9778
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 3.0377 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.0377 - accuracy: 0.9833
result on validation: 0.9813
result on test: 0.9705
=====fold 7:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.6823 - accuracy: 0.3694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 24s 863ms/step - loss: 9.6823 - accuracy: 0.3694
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.7110 - accuracy: 0.6056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 755ms/step - loss: 8.7110 - accuracy: 0.6056
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.0470 - accuracy: 0.7611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 8.0470 - accuracy: 0.7611
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7927 - accuracy: 0.7667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 7.7927 - accuracy: 0.7667
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.4301 - accuracy: 0.8389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 7.4301 - accuracy: 0.8389
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.1534 - accuracy: 0.8611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 7.1534 - accuracy: 0.8611
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.8845 - accuracy: 0.8583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 6.8845 - accuracy: 0.8583
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.6643 - accuracy: 0.8833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 6.6643 - accuracy: 0.8833
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.4459 - accuracy: 0.9056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 779ms/step - loss: 6.4459 - accuracy: 0.9056
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.2112 - accuracy: 0.9278WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 6.2112 - accuracy: 0.9278
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.0233 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js model only with val_loss available, skipping.
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12/12 [=====] - 10s 768ms/step - loss: 6.0233 - accuracy: 0.9417
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 5.8710 - accuracy: 0.9222WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 5.8710 - accuracy: 0.9222
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.6820 - accuracy: 0.9278WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.6820 - accuracy: 0.9278
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.4677 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 5.4677 - accuracy: 0.9611
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.3061 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.3061 - accuracy: 0.9611
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.2000 - accuracy: 0.9444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 5.2000 - accuracy: 0.9444
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.0136 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 880ms/step - loss: 5.0136 - accuracy: 0.9611
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 4.8691 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 4.8691 - accuracy: 0.9750
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.7623 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.7623 - accuracy: 0.9556
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.6597 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 4.6597 - accuracy: 0.9389
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.4965 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 4.4965 - accuracy: 0.9694
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.3493 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 4.3493 - accuracy: 0.9861
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.2499 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 4.2499 - accuracy: 0.9667
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.1441 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 4.1441 - accuracy: 0.9806
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.0671 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 874ms/step - loss: 4.0671 - accuracy: 0.9722
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 3.9403 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 3.9403 - accuracy: 0.9750
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 3.8502 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.8502 - accuracy: 0.9806
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.7276 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.7276 - accuracy: 0.9833
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.6400 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 3.6400 - accuracy: 0.9889
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12/12 [=====] - ETA: 0s - loss: 3.5574 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.5574 - accuracy: 0.9889
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.4600 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 3.4600 - accuracy: 0.9833
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.3743 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 784ms/step - loss: 3.3743 - accuracy: 0.9833
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.3079 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 785ms/step - loss: 3.3079 - accuracy: 0.9833
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.2610 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.2610 - accuracy: 0.9722
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.1651 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 3.1651 - accuracy: 0.9778
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.0989 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.0989 - accuracy: 0.9667
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.0487 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.0487 - accuracy: 0.9806
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 2.9530 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 2.9530 - accuracy: 0.9917
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 2.8583 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 2.8583 - accuracy: 0.9917
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 2.7985 - accuracy: 0.9917WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 2.7985 - accuracy: 0.9917
result on validation: 0.9657
result on test: 0.9398
=====fold 8:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.7031 - accuracy: 0.3556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 24s 755ms/step - loss: 9.7031 - accuracy: 0.3556
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.7525 - accuracy: 0.5528WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 8.7525 - accuracy: 0.5528
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.2242 - accuracy: 0.7083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 8.2242 - accuracy: 0.7083
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7100 - accuracy: 0.8083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 7.7100 - accuracy: 0.8083
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.5305 - accuracy: 0.8139WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 7.5305 - accuracy: 0.8139
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.2009 - accuracy: 0.8694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 7.2009 - accuracy: 0.8694
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.9476 - accuracy: 0.8972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 6.9476 - accuracy: 0.8972
result on validation: 0.8972
result on test: 0.8972
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js, skipping.
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WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 862ms/step - loss: 6.9476 - accuracy: 0.8972
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7806 - accuracy: 0.8861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 6.7806 - accuracy: 0.8861
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.5773 - accuracy: 0.9028WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 6.5773 - accuracy: 0.9028
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.3903 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.3903 - accuracy: 0.9111
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.2044 - accuracy: 0.9167WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 6.2044 - accuracy: 0.9167
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0070 - accuracy: 0.9278WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 774ms/step - loss: 6.0070 - accuracy: 0.9278
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.8483 - accuracy: 0.9333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.8483 - accuracy: 0.9333
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.6956 - accuracy: 0.9500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.6956 - accuracy: 0.9500
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.5389 - accuracy: 0.9472WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 878ms/step - loss: 5.5389 - accuracy: 0.9472
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.4131 - accuracy: 0.9333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 5.4131 - accuracy: 0.9333
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.2169 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 5.2169 - accuracy: 0.9556
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.0664 - accuracy: 0.9583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 5.0664 - accuracy: 0.9583
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.9608 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 4.9608 - accuracy: 0.9556
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.8060 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 4.8060 - accuracy: 0.9611
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.6755 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 4.6755 - accuracy: 0.9694
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.5537 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 4.5537 - accuracy: 0.9722
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.4413 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 778ms/step - loss: 4.4413 - accuracy: 0.9639
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.3410 - accuracy: 0.9556WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 782ms/step - loss: 4.3410 - accuracy: 0.9556
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.2134 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - 10s 762ms/step - loss: 4.2134 - accuracy: 0.9667
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Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.1284 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.1284 - accuracy: 0.9667
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.0091 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 4.0091 - accuracy: 0.9861
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.8802 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 775ms/step - loss: 3.8802 - accuracy: 0.9833
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.7870 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 3.7870 - accuracy: 0.9778
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.7064 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.7064 - accuracy: 0.9722
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.5832 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.5832 - accuracy: 0.9944
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.5214 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 868ms/step - loss: 3.5214 - accuracy: 0.9750
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.4620 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.4620 - accuracy: 0.9750
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.3473 - accuracy: 0.9889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.3473 - accuracy: 0.9889
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.2800 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.2800 - accuracy: 0.9778
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.1928 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 3.1928 - accuracy: 0.9750
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.0832 - accuracy: 0.9944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 3.0832 - accuracy: 0.9944
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.0111 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 3.0111 - accuracy: 0.9861
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 2.9523 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 2.9523 - accuracy: 0.9833
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 2.9077 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 868ms/step - loss: 2.9077 - accuracy: 0.9861
result on validation: 0.9564
result on test: 0.9483
=====fold 9:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.7079 - accuracy: 0.3000WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 24s 772ms/step - loss: 9.7079 - accuracy: 0.3000
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.9180 - accuracy: 0.5028WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 794ms/step - loss: 8.9180 - accuracy: 0.5028
Epoch 3/40
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js [=====] - ETA: 0s - loss: 8.2566 - accuracy: 0.6556WARNING:tensorflow:Can save best mo
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del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 8.2566 - accuracy: 0.6556
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.9850 - accuracy: 0.7500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 7.9850 - accuracy: 0.7500
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.6604 - accuracy: 0.7611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 7.6604 - accuracy: 0.7611
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.3718 - accuracy: 0.8056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 7.3718 - accuracy: 0.8056
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 7.0157 - accuracy: 0.8444WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 7.0157 - accuracy: 0.8444
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7705 - accuracy: 0.8806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 6.7705 - accuracy: 0.8806
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.6133 - accuracy: 0.8333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 6.6133 - accuracy: 0.8333
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.3547 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 878ms/step - loss: 6.3547 - accuracy: 0.9111
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.2287 - accuracy: 0.8944WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.2287 - accuracy: 0.8944
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0172 - accuracy: 0.9083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 775ms/step - loss: 6.0172 - accuracy: 0.9083
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.8091 - accuracy: 0.9222WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 5.8091 - accuracy: 0.9222
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.6463 - accuracy: 0.9306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 5.6463 - accuracy: 0.9306
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.4509 - accuracy: 0.9389WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 5.4509 - accuracy: 0.9389
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.3181 - accuracy: 0.9500WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 5.3181 - accuracy: 0.9500
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.1654 - accuracy: 0.9528WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.1654 - accuracy: 0.9528
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.0534 - accuracy: 0.9583WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 878ms/step - loss: 5.0534 - accuracy: 0.9583
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 4.9270 - accuracy: 0.9667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 770ms/step - loss: 4.9270 - accuracy: 0.9667
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.8062 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.8062 - accuracy: 0.9694
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.6950 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
Loading [MathJax]/jax/output/CommonHTML/fonts/TeX/fontdata.js model only with val_loss available, skipping.
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12/12 [=====] - 10s 765ms/step - loss: 4.6950 - accuracy: 0.9639
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.5649 - accuracy: 0.9750WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.5649 - accuracy: 0.9750
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.4453 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 4.4453 - accuracy: 0.9806
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.3405 - accuracy: 0.9722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.3405 - accuracy: 0.9722
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.2411 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 4.2411 - accuracy: 0.9833
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.1446 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 786ms/step - loss: 4.1446 - accuracy: 0.9806
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.0407 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 803ms/step - loss: 4.0407 - accuracy: 0.9861
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 3.9603 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.9603 - accuracy: 0.9861
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.8718 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.8718 - accuracy: 0.9861
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.7526 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.7526 - accuracy: 0.9861
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.6976 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.6976 - accuracy: 0.9833
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.6447 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.6447 - accuracy: 0.9833
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.5243 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 772ms/step - loss: 3.5243 - accuracy: 0.9833
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.4764 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.4764 - accuracy: 0.9833
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.3921 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 881ms/step - loss: 3.3921 - accuracy: 0.9806
Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.3376 - accuracy: 0.9694WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.3376 - accuracy: 0.9694
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.2633 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 768ms/step - loss: 3.2633 - accuracy: 0.9833
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.1843 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 3.1843 - accuracy: 0.9861
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.1000 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 3.1000 - accuracy: 0.9778
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12/12 [=====] - ETA: 0s - loss: 3.0377 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 771ms/step - loss: 3.0377 - accuracy: 0.9833
result on validation: 0.9457
result on test: 0.9597
=====fold 10:=====
Found 360 validated image filenames belonging to 5 classes.
Found 40 validated image filenames belonging to 5 classes.
Epoch 1/40
12/12 [=====] - ETA: 0s - loss: 9.5499 - accuracy: 0.3722WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 22s 756ms/step - loss: 9.5499 - accuracy: 0.3722
Epoch 2/40
12/12 [=====] - ETA: 0s - loss: 8.7853 - accuracy: 0.5667WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 8.7853 - accuracy: 0.5667
Epoch 3/40
12/12 [=====] - ETA: 0s - loss: 8.1321 - accuracy: 0.7056WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 8.1321 - accuracy: 0.7056
Epoch 4/40
12/12 [=====] - ETA: 0s - loss: 7.7410 - accuracy: 0.7972WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 7.7410 - accuracy: 0.7972
Epoch 5/40
12/12 [=====] - ETA: 0s - loss: 7.4951 - accuracy: 0.8111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 7.4951 - accuracy: 0.8111
Epoch 6/40
12/12 [=====] - ETA: 0s - loss: 7.2722 - accuracy: 0.8333WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 7.2722 - accuracy: 0.8333
Epoch 7/40
12/12 [=====] - ETA: 0s - loss: 6.8979 - accuracy: 0.8861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 6.8979 - accuracy: 0.8861
Epoch 8/40
12/12 [=====] - ETA: 0s - loss: 6.7501 - accuracy: 0.9083WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 789ms/step - loss: 6.7501 - accuracy: 0.9083
Epoch 9/40
12/12 [=====] - ETA: 0s - loss: 6.5204 - accuracy: 0.9250WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 6.5204 - accuracy: 0.9250
Epoch 10/40
12/12 [=====] - ETA: 0s - loss: 6.3939 - accuracy: 0.8889WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 6.3939 - accuracy: 0.8889
Epoch 11/40
12/12 [=====] - ETA: 0s - loss: 6.2307 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 6.2307 - accuracy: 0.9111
Epoch 12/40
12/12 [=====] - ETA: 0s - loss: 6.0869 - accuracy: 0.9111WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 6.0869 - accuracy: 0.9111
Epoch 13/40
12/12 [=====] - ETA: 0s - loss: 5.9048 - accuracy: 0.9194WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 5.9048 - accuracy: 0.9194
Epoch 14/40
12/12 [=====] - ETA: 0s - loss: 5.7302 - accuracy: 0.9417WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 5.7302 - accuracy: 0.9417
Epoch 15/40
12/12 [=====] - ETA: 0s - loss: 5.6024 - accuracy: 0.9306WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 762ms/step - loss: 5.6024 - accuracy: 0.9306
Epoch 16/40
12/12 [=====] - ETA: 0s - loss: 5.4396 - accuracy: 0.9611WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 871ms/step - loss: 5.4396 - accuracy: 0.9611
Epoch 17/40
12/12 [=====] - ETA: 0s - loss: 5.2816 - accuracy: 0.9639WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 871ms/step - loss: 5.2816 - accuracy: 0.9639
```

WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 5.2816 - accuracy: 0.9639
Epoch 18/40
12/12 [=====] - ETA: 0s - loss: 5.1741 - accuracy: 0.9556WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 5.1741 - accuracy: 0.9556
Epoch 19/40
12/12 [=====] - ETA: 0s - loss: 5.0226 - accuracy: 0.9444WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 5.0226 - accuracy: 0.9444
Epoch 20/40
12/12 [=====] - ETA: 0s - loss: 4.9122 - accuracy: 0.9528WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.9122 - accuracy: 0.9528
Epoch 21/40
12/12 [=====] - ETA: 0s - loss: 4.7756 - accuracy: 0.9611WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 764ms/step - loss: 4.7756 - accuracy: 0.9611
Epoch 22/40
12/12 [=====] - ETA: 0s - loss: 4.6772 - accuracy: 0.9611WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.6772 - accuracy: 0.9611
Epoch 23/40
12/12 [=====] - ETA: 0s - loss: 4.5137 - accuracy: 0.9861WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 765ms/step - loss: 4.5137 - accuracy: 0.9861
Epoch 24/40
12/12 [=====] - ETA: 0s - loss: 4.4212 - accuracy: 0.9778WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.4212 - accuracy: 0.9778
Epoch 25/40
12/12 [=====] - ETA: 0s - loss: 4.3269 - accuracy: 0.9694WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 859ms/step - loss: 4.3269 - accuracy: 0.9694
Epoch 26/40
12/12 [=====] - ETA: 0s - loss: 4.2421 - accuracy: 0.9556WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 4.2421 - accuracy: 0.9556
Epoch 27/40
12/12 [=====] - ETA: 0s - loss: 4.1896 - accuracy: 0.9500WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 760ms/step - loss: 4.1896 - accuracy: 0.9500
Epoch 28/40
12/12 [=====] - ETA: 0s - loss: 4.0371 - accuracy: 0.9889WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 761ms/step - loss: 4.0371 - accuracy: 0.9889
Epoch 29/40
12/12 [=====] - ETA: 0s - loss: 3.9679 - accuracy: 0.9694WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.9679 - accuracy: 0.9694
Epoch 30/40
12/12 [=====] - ETA: 0s - loss: 3.8724 - accuracy: 0.9722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 763ms/step - loss: 3.8724 - accuracy: 0.9722
Epoch 31/40
12/12 [=====] - ETA: 0s - loss: 3.7917 - accuracy: 0.9778WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 756ms/step - loss: 3.7917 - accuracy: 0.9778
Epoch 32/40
12/12 [=====] - ETA: 0s - loss: 3.6880 - accuracy: 0.9944WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 3.6880 - accuracy: 0.9944
Epoch 33/40
12/12 [=====] - ETA: 0s - loss: 3.6216 - accuracy: 0.9806WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 769ms/step - loss: 3.6216 - accuracy: 0.9806
Epoch 34/40
12/12 [=====] - ETA: 0s - loss: 3.5248 - accuracy: 0.9889WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 11s 863ms/step - loss: 3.5248 - accuracy: 0.9889
Epoch 35/40
12/12 [=====] - ETA: 0s - loss: 3.4675 - accuracy: 0.9722WARNING:tensorflow:Can save best model only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 773ms/step - loss: 3.4675 - accuracy: 0.9722

```

Epoch 36/40
12/12 [=====] - ETA: 0s - loss: 3.4004 - accuracy: 0.9806WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 766ms/step - loss: 3.4004 - accuracy: 0.9806
Epoch 37/40
12/12 [=====] - ETA: 0s - loss: 3.3227 - accuracy: 0.9861WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 759ms/step - loss: 3.3227 - accuracy: 0.9861
Epoch 38/40
12/12 [=====] - ETA: 0s - loss: 3.2586 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 757ms/step - loss: 3.2586 - accuracy: 0.9833
Epoch 39/40
12/12 [=====] - ETA: 0s - loss: 3.2131 - accuracy: 0.9833WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 758ms/step - loss: 3.2131 - accuracy: 0.9833
Epoch 40/40
12/12 [=====] - ETA: 0s - loss: 3.1373 - accuracy: 0.9778WARNING:tensorflow:Can save best mo
del only with val_loss available, skipping.
WARNING:tensorflow:Can save best model only with val_loss available, skipping.
12/12 [=====] - 10s 767ms/step - loss: 3.1373 - accuracy: 0.9778
result on validation: 0.9689
result on test: 0.9691

```

```

In [ ]: print(f"Accuracies: {kf_accuracies}")
        print(f"Losses: {kf_losses}")

        print(f"Average of accuracies: {np.mean(kf_accuracies)}")
        print(f"Average of losses: {np.mean(kf_losses)}")

```

```

Accuracies: [0.9113, 0.9317, 0.9189, 0.9433, 0.9633, 0.9705, 0.9398, 0.9483, 0.9597, 0.9691]
Losses: [3.15283999, 2.97926519, 3.08569868, 2.94691874, 2.95199153, 2.95831778, 3.05236261, 2.94782078, 2.87663417,
3.00295017]
Average of accuracies: 0.9455899999999999
Average of losses: 2.995479964

```