```
!pip install kaggle
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/public/simple/
Requirement already satisfied: kaggle in /usr/local/lib/python3.10/dist-packages (1.5.13)
Requirement already satisfied: tqdm in /usr/local/lib/python3.10/dist-packages (from kaggle) (4.65.0)
Requirement already satisfied: certifi in /usr/local/lib/python3.10/dist-packages (from kaggle) (2022.12.7)
Requirement already satisfied: python-dateutil in /usr/local/lib/python3.10/dist-packages (from kaggle) (2.8.2)
Requirement already satisfied: python-slugify in /usr/local/lib/python3.10/dist-packages (from kaggle) (8.0.1)
Requirement already satisfied: requests in /usr/local/lib/python3.10/dist-packages (from kaggle) (2.27.1)
Requirement already satisfied: urllib3 in /usr/local/lib/python3.10/dist-packages (from kaggle) (1.26.15)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.10/dist-packages (from kaggle) (1.16.0)
Requirement already satisfied: text-unidecode>=1.3 in /usr/local/lib/python3.10/dist-packages (from python-slugify->kaggle) (1.3)
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.10/dist-packages (from requests->kaggle) (2.0.12)
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.10/dist-packages (from requests->kaggle) (3.4)
```

```
!mkdir -p ~/.kaggle
!cp kaggle.json ~/.kaggle/
```

```
!kaggle datasets download -d aryashah2k/mango-leaf-disease-dataset
```

```
Warning: Your Kaggle API key is readable by other users on this system! To fix this, you can run 'chmod 600 /root/.kaggle/kaggle.json'
Downloading mango-leaf-disease-dataset.zip to /content
 90% 93.0M/103M [00:00<00:00, 215MB/s]
100% 103M/103M [00:00<00:00, 186MB/s]
```

```
#extracting files
from zipfile import ZipFile

with ZipFile('mango-leaf-disease-dataset.zip', 'r') as f:

 #extract in different directory
 f.extractall('images')
```

```
import os
import shutil
import random
import tensorflow as tf
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from pathlib import Path
import glob
import cv2

root_directory = "/content/images"
train_ratio = 0.7
val_ratio = 0.15
test_ratio = 0.15

subfolders = [f.name for f in os.scandir(root_directory) if f.is_dir()]

for subfolder in subfolders:
    subfolder_path = os.path.join(root_directory, subfolder)
    images = [f.name for f in os.scandir(subfolder_path) if f.is_file()]

    random.shuffle(images)

    num_images = len(images)
    num_train = int(num_images * train_ratio)
    num_val = int(num_images * val_ratio)
    num_test = num_images - num_train - num_val

    train_images = images[:num_train]
    val_images = images[num_train:num_train + num_val]
    test_images = images[num_train + num_val:]

    train_dir = os.path.join(root_directory, 'train', subfolder)
    val_dir = os.path.join(root_directory, 'val', subfolder)
    test_dir = os.path.join(root_directory, 'test', subfolder)
    os.makedirs(train_dir, exist_ok=True)
    os.makedirs(val_dir, exist_ok=True)
    os.makedirs(test_dir, exist_ok=True)
```

```
        for image in train_images:
            src = os.path.join(subfolder_path, image)
            dst = os.path.join(train_dir, image)
            shutil.move(src, dst)

        for image in val_images:
            src = os.path.join(subfolder_path, image)
            dst = os.path.join(val_dir, image)
            shutil.move(src, dst)

        for image in test_images:
            src = os.path.join(subfolder_path, image)
            dst = os.path.join(test_dir, image)
            shutil.move(src, dst)

        os.rmdir(subfolder_path) #deleting empty folders


    #optional code for debugging- can be excluded
    #testing whether the subfolders are formed after the above action
    data_dir_of_test = '../content/images/test'
    print(os.listdir(data_dir))
```

```
['Die Back', 'Healthy', 'Anthracnose', 'Gall Midge', 'Cutting Weevil', 'Sooty Mould', 'Powdery Mildew', 'Bacterial Canker']
```

```
    #optional code for debugging- can be excluded
    #The total images count is 4000
    #Testing to double check with the number of images from the root folder

    subfolder_path = "/content/images"
    valid_extensions = (".jpg", ".jpeg", ".png")

    def count_images(folder):
        image_count = 0
        for root, dirs, files in os.walk(folder):
            for file_name in files:
                if file_name.lower().endswith(valid_extensions):
                    image_count += 1
        return image_count

    total_image_count = count_images(subfolder_path)

    print(f"Total number of images in the main folder and its subfolders: {total_image_count}")
```

```
Total number of images in the main folder and its subfolders: 4000
```

```
    # Creating the Pathlib PATH objects for train and val
    train_path = Path("/content/images/train")
    valid_path = Path("/content/images/val")
    test_path=Path("/content/images/test")


    #finding the average size of images
    from PIL import Image

    data_folder = "/content/images/test"

    total_width = 0
    total_height = 0
    num_images = 0

    # Iterate over subfolders (labels)
    for label in os.listdir(data_folder):
        label_folder = os.path.join(data_folder, label)
        if os.path.isdir(label_folder):
            # Iterate over image files in the label folder
            for image_file in os.listdir(label_folder):
                if image_file.endswith(".jpg") or image_file.endswith(".png"):
                    # Open the image using PIL
                    image_path = os.path.join(label_folder, image_file)
                    image = Image.open(image_path)

                    # Accumulate the width and height
                    width, height = image.size
                    total_width += width
                    total_height += height
```

```
                num_images += 1

# Calculate the average width and height
avg_width = total_width / num_images
avg_height = total_height / num_images

# Print the average width and height
print("Average Width:", avg_width)
print("Average Height:", avg_height)
```

```
Average Width: 273.92333333333335
Average Height: 261.5283333333333
```

```
batch_size = 72
epochs = 45
img_channel = 9
data_dir="../content/images"
img_width, img_height = (273.92,261.52)
train_dataset_main = data_dir + "/train"
valid_dataset_main = data_dir + "/val"


#creating DF's
def create_dataset_df(main_path, dataset_name):
    print(f"{dataset_name} is creating ...")
    df = {"img_path":[],"class_names":[]}
    for class_names in os.listdir(main_path):
            for img_path in glob.glob(f"{main_path}/{class_names}/*"):
                df["img_path"].append(img_path)
                df["class_names"].append(class_names)
    df = pd.DataFrame(df)
    print(f"{dataset_name} is created !")
    return df


train_df = create_dataset_df(train_dataset_main, "Train dataset")

valid_df=create_dataset_df(valid_dataset_main, "Validation dataset")

print(f"train samples: {len(train_df)} \n validation samples: {len(valid_df)}")
def vizualizing_images(df,n_rows,n_cols):
    plt.figure(figsize=(10,10))
    for i in range(n_rows*n_cols):
        index = np.random.randint(0, len(df))
        img = cv2.imread(df.img_path[index])
        class_nm = df.class_names[index]
        plt.subplot(n_rows, n_cols, i+1)
        plt.imshow(img)
        plt.title(class_nm)
    plt.show()
vizualizing_images(train_df, 3, 3)

plt.figure(figsize=(25,5))
# train dataset
plt.subplot(1,2,1)
sns.countplot(data=train_df.sort_values("class_names"),x="class_names")
plt.title("Train dataset")
plt.xticks(rotation = 60)
# validation dataset
plt.subplot(1,2,2)
sns.countplot(data=valid_df.sort_values("class_names"),x="class_names")
plt.title("Validation dataset")
plt.xticks(rotation = 60)

plt.show()

from sklearn.preprocessing import LabelEncoder

Le = LabelEncoder()
train_df["class_names"] = Le.fit_transform(train_df["class_names"])

#train_df["class_names"].value_counts()


valid_df["class_names"] = Le.transform(valid_df["class_names"])
#One Hot encoding
train_labels = tf.keras.utils.to_categorical(train_df["class_names"])
```

```
valid_labels = tf.keras.utils.to_categorical(valid_df["class_names"])
train_labels[:10]
train_labels.sum(axis=0)

# Compute class weights

classTotals = train_labels.sum(axis=0)
classWeight = classTotals.max() / classTotals

class_weight = {e : weight for e , weight in enumerate(classWeight)}
print(class_weight)
input_image = cv2.imread(train_df.img_path[0])

input_image.shape
```

```
def load(image , label):
    image = tf.io.read_file(image)
    image = tf.io.decode_jpeg(image , channels = 3)
    return image , label

IMG_SIZE = 96
BATCH_SIZE = 64

# Basic Transformation
```

```
resize = tf.keras.Sequential([
    tf.keras.layers.experimental.preprocessing.Resizing(IMG_SIZE, IMG_SIZE)
])

# Data Augmentation
data_augmentation = tf.keras.Sequential([
    tf.keras.layers.experimental.preprocessing.RandomFlip("horizontal"),
    tf.keras.layers.experimental.preprocessing.RandomRotation(0.1),
    tf.keras.layers.experimental.preprocessing.RandomZoom(height_factor = (-0.1, -0.05))
])

# Function used to Create a Tensorflow Data Object
AUTOTUNE = tf.data.experimental.AUTOTUNE #to find a good allocation of its CPU budget across all parameters
def get_dataset(paths , labels , train = True):
    image_paths = tf.convert_to_tensor(paths)
    labels = tf.convert_to_tensor(labels)

    image_dataset = tf.data.Dataset.from_tensor_slices(image_paths)
    label_dataset = tf.data.Dataset.from_tensor_slices(labels)

    dataset = tf.data.Dataset.zip((image_dataset , label_dataset))

    dataset = dataset.map(lambda image , label : load(image , label))
    dataset = dataset.map(lambda image, label: (resize(image), label) , num_parallel_calls=AUTOTUNE)
    dataset = dataset.shuffle(1000)
    dataset = dataset.batch(BATCH_SIZE)

    if train:
        dataset = dataset.map(lambda image, label: (data_augmentation(image), label) , num_parallel_calls=AUTOTUNE)
        dataset = dataset.repeat()

    return dataset

# Creating Train Dataset object and Verifying it
%time
train_dataset = get_dataset(train_df["img_path"], train_labels)

#iter() returns an iterator of the given object
#next() returns the next number in an iterator
image , label = next(iter(train_dataset))
print(image.shape)
print(label.shape)
# View a sample Training Image
print(Le.inverse_transform(np.argmax(label , axis = 1))[0])
plt.imshow((image[0].numpy()/255).reshape(96 , 96 , 3))


%time
val_dataset = get_dataset(valid_df["img_path"] , valid_labels , train = False)

image , label = next(iter(val_dataset))
print(image.shape)
print(label.shape)

# View a sample Validation Image
print(Le.inverse_transform(np.argmax(label , axis = 1))[0])
plt.imshow((image[0].numpy()/255).reshape(96 , 96 , 3))


# Building EfficientNet model
from tensorflow.keras.applications import EfficientNetB2
from tensorflow.keras.layers import Conv2D, BatchNormalization, Activation, MaxPooling2D, Dropout, Dense, Input, GlobalAveragePooling2D


backbone = EfficientNetB2(
    input_shape=(96, 96, 3),
    include_top=False
)

n = 64
model = tf.keras.Sequential([
    backbone,
    tf.keras.layers.Conv2D(128, 3, padding='same'),
    tf.keras.layers.BatchNormalization(),
    tf.keras.layers.Activation('relu'),
    tf.keras.layers.Conv2D(64, 3, padding='same'),
    tf.keras.layers.BatchNormalization(),
```

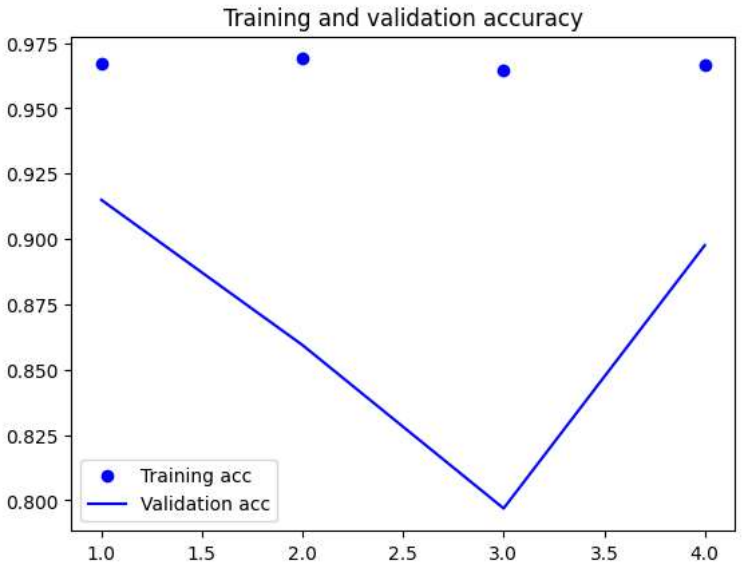
```
        tf.keras.layers.Activation('relu'),
        tf.keras.layers.Conv2D(32, 3, padding='same'),
        tf.keras.layers.BatchNormalization(),
        tf.keras.layers.Activation('relu'),
        tf.keras.layers.GlobalAveragePooling2D(),
        tf.keras.layers.Dense(128),
        tf.keras.layers.Activation('relu'),
        tf.keras.layers.Dropout(0.3),
        tf.keras.layers.Dense(8, activation='softmax')
    ])

    model.summary()

    # Compiling your model by providing the Optimizer , Loss and Metrics
    model.compile(
        optimizer=tf.keras.optimizers.Adam(learning_rate=0.001, beta_1=0.9, beta_2=0.999, epsilon=1e-07),
        loss = 'categorical_crossentropy',
        metrics=['accuracy' , tf.keras.metrics.Precision(name='precision'),tf.keras.metrics.Recall(name='recall')]
    )
    #
    len(train_labels),len(valid_labels)
```

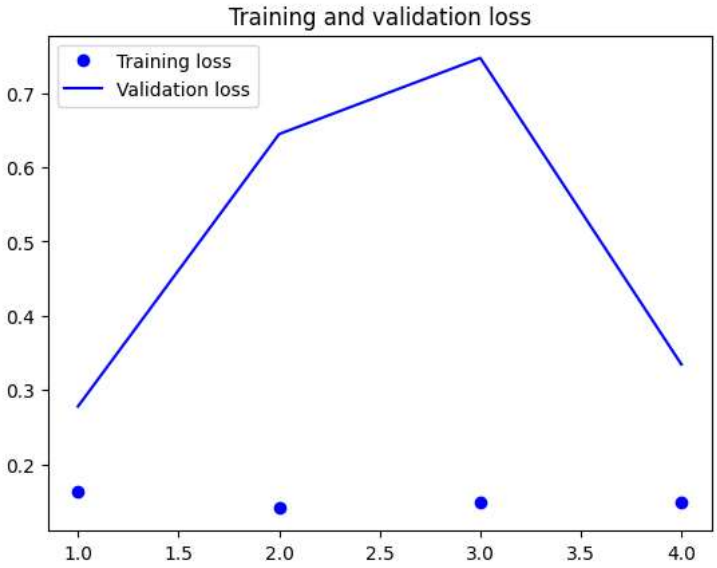
```
    early_stopping=tf.keras.callbacks.EarlyStopping(monitor="accuracy",patience=2,mode="auto")
    # Train the model
```

```
history = model.fit(
    train_dataset,
    steps_per_epoch=len(train_labels)//BATCH_SIZE,
    epochs=12,
    callbacks=[early_stopping],
    validation_data=val_dataset,
    validation_steps = len(valid_labels)//BATCH_SIZE,
    class_weight=class_weight
)
model.layers[0].trainable = False
# Defining our callbacks
checkpoint = tf.keras.callbacks.ModelCheckpoint("best_weights.h5",verbose=1,save_best_only=True,save_weights_only = True)
early_stop = tf.keras.callbacks.EarlyStopping(monitor="accuracy",patience=2)
model.summary()


# 2nd Train the model
history = model.fit(
    train_dataset,
    steps_per_epoch=len(train_labels)//BATCH_SIZE,
    epochs=8,
    callbacks=[checkpoint , early_stop],
    validation_data=val_dataset,
    validation_steps = len(valid_labels)//BATCH_SIZE,
    class_weight=class_weight
)
```

```
Epoch 1/12
43/43 [==============================] - 288s 6s/step - loss: 1.5396 - accuracy: 0.4811 - precision: 0.9267 - recall: 0.2482 - val_lo
Epoch 2/12
43/43 [==============================] - 237s 6s/step - loss: 1.1203 - accuracy: 0.6155 - precision: 0.9000 - recall: 0.4375 - val_lo
Epoch 3/12
43/43 [==============================] - 238s 6s/step - loss: 1.0123 - accuracy: 0.6667 - precision: 0.8850 - recall: 0.4949 - val_lo
Epoch 4/12
43/43 [==============================] - 239s 6s/step - loss: 0.8265 - accuracy: 0.7591 - precision: 0.8815 - recall: 0.5658 - val_lo
Epoch 5/12
43/43 [==============================] - 237s 6s/step - loss: 0.7749 - accuracy: 0.7781 - precision: 0.8702 - recall: 0.6319 - val_lo
Epoch 6/12
43/43 [==============================] - 237s 6s/step - loss: 0.6030 - accuracy: 0.8242 - precision: 0.8711 - recall: 0.7387 - val_lo
Epoch 7/12
43/43 [==============================] - 237s 6s/step - loss: 0.6424 - accuracy: 0.8176 - precision: 0.8483 - recall: 0.7504 - val_lo
Epoch 8/12
43/43 [==============================] - 236s 6s/step - loss: 0.5231 - accuracy: 0.8534 - precision: 0.8893 - recall: 0.8048 - val_lo
Epoch 9/12
43/43 [==============================] - 235s 5s/step - loss: 0.4090 - accuracy: 0.8951 - precision: 0.9149 - recall: 0.8728 - val_lo
Epoch 10/12
43/43 [==============================] - 239s 6s/step - loss: 0.3231 - accuracy: 0.9225 - precision: 0.9370 - recall: 0.9031 - val_lo
Epoch 11/12
43/43 [==============================] - 237s 6s/step - loss: 0.2315 - accuracy: 0.9441 - precision: 0.9552 - recall: 0.9357 - val_lo
Epoch 12/12
43/43 [==============================] - 237s 5s/step - loss: 0.2193 - accuracy: 0.9496 - precision: 0.9572 - recall: 0.9404 - val_lo
Model: "sequential_6"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 efficientnetb2 (Functional)  (None, 3, 3, 1408)       7768569

 conv2d (Conv2D)             (None, 3, 3, 128)         1622144

 batch_normalization (BatchN  (None, 3, 3, 128)        512
 ormalization)

 activation (Activation)     (None, 3, 3, 128)         0

 conv2d_1 (Conv2D)           (None, 3, 3, 64)          73792

 batch_normalization_1 (Batc  (None, 3, 3, 64)         256
 hNormalization)

 activation_1 (Activation)   (None, 3, 3, 64)          0

 conv2d_2 (Conv2D)           (None, 3, 3, 32)          18464

 batch_normalization_2 (Batc  (None, 3, 3, 32)         128
 hNormalization)

 activation_2 (Activation)   (None, 3, 3, 32)          0

 global_average_pooling2d (G  (None, 32)               0
 lobalAveragePooling2D)

 dense (Dense)               (None, 128)               4224
```

```
acc = history.history['accuracy']
val_acc = history.history['val_accuracy']
loss = history.history['loss']
val_loss = history.history['val_loss']

import matplotlib.pyplot as plt

epochs = range(1, len(acc) + 1)

plt.plot(epochs, acc, 'bo', label='Training acc')
plt.plot(epochs, val_acc, 'b', label='Validation acc')
plt.title('Training and validation accuracy')
plt.legend()

plt.figure()

plt.plot(epochs, loss, 'bo', label='Training loss')
plt.plot(epochs, val_loss, 'b', label='Validation loss')
plt.title('Training and validation loss')
plt.legend()
plt.show()
```





Reference: https://levity.ai/blog/what-is-an-image-classifier https://developer.apple.com/documentation/createml/creating-an-image-classifier-model https://www.geeksforgeeks.org/how-to-find-width-and-height-of-an-image-using-python/ https://www.studytonight.com/python-howtos/how-to-unzip-file-in-python#:~:text=To%20unzip%20it%20first%20create,it%20will%20overwrite%20the%20path. https://www.tensorflow.org/tutorials/images/classification