Import neccessary packages

```
! pip install kaggle
```

```
Looking in indexes: https://pypi.org/simple, https://us-python.pkg.dev/colab-wheels/publ
Requirement already satisfied: kaggle in /usr/local/lib/python3.9/dist-packages (1.5.13)
Requirement already satisfied: six>=1.10 in /usr/local/lib/python3.9/dist-packages (from
Requirement already satisfied: certifi in /usr/local/lib/python3.9/dist-packages (from k
Requirement already satisfied: urllib3 in /usr/local/lib/python3.9/dist-packages (from k
Requirement already satisfied: python-slugify in /usr/local/lib/python3.9/dist-packages
Requirement already satisfied: tqdm in /usr/local/lib/python3.9/dist-packages (from kagg
Requirement already satisfied: requests in /usr/local/lib/python3.9/dist-packages (from
Requirement already satisfied: python-dateutil in /usr/local/lib/python3.9/dist-packages
Requirement already satisfied: text-unidecode>=1.3 in /usr/local/lib/python3.9/dist-pack
Requirement already satisfied: idna<4,>=2.5 in /usr/local/lib/python3.9/dist-packages (f
Requirement already satisfied: charset-normalizer~=2.0.0 in /usr/local/lib/python3.9/dis
```

```
from google.colab import drive
drive.mount('/content/gdrive')
```

```
Mounted at /content/gdrive
```

```
from google.colab import files
files.upload()
```

Choose Files No file chosen Upload widget is only available when the cell has been executed in the current browser session. Please rerun this cell to enable.

```
Saving kaggle.json to kaggle (1).json
{'kaggle.json':
```

```
!ls -lha kaggle.json
```

```
-rw-r--r-- 1 root root 75 Apr 20 23:00 kaggle.json
```

```
!pip install -q kaggle
```

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

```
!cp kaggle.json ~/.kaggle/
```

```
!chmod 600 /root/.kaggle/kaggle.json
```

```
!pwd
```

```
/content
```

```
!kaggle datasets download -d emmarex/plantdisease
```

```
plantdisease.zip: Skipping, found more recently modified local copy (use --force to forc
```

```
! unzip plantdisease.zip
```

```
Archive:  plantdisease.zip
replace PlantVillage/Pepper__bell___Bacterial_spot/0022d6b7-d47c-4ee2-ae9a-392a53f48647_
replace PlantVillage/Pepper__bell___Bacterial_spot/006adb74-934f-448f-a14f-62181742127b_
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.moun
```

```
import numpy as np
import pickle
import cv2
from os import listdir
from sklearn.preprocessing import LabelBinarizer
from keras.models import Sequential
from tensorflow.keras.layers import BatchNormalization
from keras.layers.convolutional import Conv2D
from keras.layers.convolutional import MaxPooling2D
from keras.layers.core import Activation, Flatten, Dropout, Dense
from keras import backend as K
from keras.preprocessing.image import ImageDataGenerator
from keras.optimizers import Adam
from keras.preprocessing import image
from tensorflow.keras.preprocessing.image import img_to_array
from sklearn.preprocessing import MultiLabelBinarizer
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
```

```
EPOCHS = 25
INIT_LR = 1e-3
BS = 32
default_image_size = tuple((256, 256))
image_size = 0
directory_root = '/content/plantvillage'
width=256
height=256
depth=3
```

Function to convert images to array

```
def convert_image_to_array(image_dir):
    try:
        image = cv2.imread(image_dir)
        if image is not None :
            image = cv2.resize(image, default_image_size)
            return img_to_array(image)
        else :
            return np.array([])
    except Exception as e:
        print(f"Error : {e}")
        return None
```

Fetch images from directory

```
import os

image_list, label_list = [], []
try:
    print("[INFO] Loading images ...")
    root_dir = os.listdir(directory_root)
    for directory in root_dir :
        # remove .DS_Store from list
        if directory == ".DS_Store" :
            root_dir.remove(directory)

    for plant_folder in root_dir :
        plant_folder_path = os.path.join(directory_root, plant_folder)
        if os.path.isdir(plant_folder_path):
            plant_disease_folder_list = os.listdir(plant_folder_path)

            for disease_folder in plant_disease_folder_list :
                # remove .DS_Store from list
                if disease_folder == ".DS_Store" :
                    plant_disease_folder_list.remove(disease_folder)

            for plant_disease_folder in plant_disease_folder_list:
                print(f"[INFO] Loading images: {plant_disease_folder} ...")
                plant_disease_folder_path = os.path.join(plant_folder_path, plant_disease_fol
                if os.path.isdir(plant_disease_folder_path):
                    print(f"[INFO] Processing {plant_disease_folder} ...")
                    plant_disease_image_list = os.listdir(plant_disease_folder_path)

                    for single_plant_disease_image in plant_disease_image_list :
                        if single_plant_disease_image == ".DS_Store" :
                            plant_disease_image_list.remove(single_plant_disease_image)
                    for image in plant_disease_image_list[:200]:
                        image_directory = os.path.join(plant_disease_folder_path, image)
                        if image_directory.endswith(".jpg") or image_directory.endswith(".JPG
                            image_list.append(convert_image_to_array(image_directory))
                            label_list.append(plant_disease_folder)
    print("[INFO] Image loading completed")
except Exception as e:
    print(f"Error : {e}")
```

```
[INFO] Loading images ...
[INFO] Loading images: Tomato_Spider_mites_Two_spotted_spider_mite ...
[INFO] Processing Tomato_Spider_mites_Two_spotted_spider_mite ...
[INFO] Loading images: Potato___healthy ...
[INFO] Processing Potato___healthy ...
[INFO] Loading images: Tomato_healthy ...
[INFO] Processing Tomato_healthy ...
[INFO] Loading images: Potato___Early_blight ...
[INFO] Processing Potato___Early_blight ...
[INFO] Loading images: Potato___Late_blight ...
[INFO] Processing Potato___Late_blight ...
[INFO] Loading images: Tomato_Late_blight ...
[INFO] Processing Tomato_Late_blight ...
[INFO] Loading images: Tomato_Early_blight ...
[INFO] Processing Tomato_Early_blight ...
[INFO] Loading images: Tomato_Bacterial_spot ...
[INFO] Processing Tomato_Bacterial_spot ...
[INFO] Loading images: Pepper__bell___healthy ...
[INFO] Processing Pepper__bell___healthy ...
[INFO] Loading images: Tomato_Septoria_leaf_spot ...
[INFO] Processing Tomato_Septoria_leaf_spot ...
[INFO] Loading images: Tomato__Tomato_mosaic_virus ...
[INFO] Processing Tomato__Tomato_mosaic_virus ...
[INFO] Loading images: Tomato__Tomato_YellowLeaf__Curl_Virus ...
[INFO] Processing Tomato__Tomato_YellowLeaf__Curl_Virus ...
[INFO] Loading images: Tomato_Leaf_Mold ...
[INFO] Processing Tomato_Leaf_Mold ...
[INFO] Loading images: Tomato__Target_Spot ...
[INFO] Processing Tomato__Target_Spot ...
[INFO] Loading images: Pepper__bell___Bacterial_spot ...
[INFO] Processing Pepper__bell___Bacterial_spot ...
[INFO] Image loading completed
```

Get Size of Processed Image

```
image_size = len(image_list)
```

```
image_size
```

```
2951
```

Transform Image Labels uisng Scikit Learn's LabelBinarizer

```
label_binarizer = LabelBinarizer()
image_labels = label_binarizer.fit_transform(label_list)
pickle.dump(label_binarizer,open('label_transform.pkl', 'wb'))
n_classes = len(label_binarizer.classes_)
```

Print the classes

```
print(label_binarizer.classes_)
```

```
['Pepper__bell___Bacterial_spot' 'Pepper__bell___healthy'
 'Potato___Early_blight' 'Potato___Late_blight' 'Potato___healthy'
 'Tomato_Bacterial_spot' 'Tomato_Early_blight' 'Tomato_Late_blight'
 'Tomato_Leaf_Mold' 'Tomato_Septoria_leaf_spot'
 'Tomato_Spider_mites_Two_spotted_spider_mite' 'Tomato__Target_Spot'
 'Tomato__Tomato_YellowLeaf__Curl_Virus' 'Tomato__Tomato_mosaic_virus'
 'Tomato_healthy']
```

```
np_image_list = np.array(image_list, dtype=np.float16) / 225.0
```

```
print("[INFO] Spliting data to train, test")
x_train, x_test, y_train, y_test = train_test_split(np_image_list, image_labels, test_size=0.
```

```
[INFO] Spliting data to train, test
```

```
aug = ImageDataGenerator(
    rotation_range=25, width_shift_range=0.1,
    height_shift_range=0.1, shear_range=0.2,
    zoom_range=0.2,horizontal_flip=True,
    fill_mode="nearest")
```

```
model = Sequential()
inputShape = (height, width, depth)
chanDim = -1
if K.image_data_format() == "channels_first":
    inputShape = (depth, height, width)
    chanDim = 1
model.add(Conv2D(32, (3, 3), padding="same",input_shape=inputShape))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(3, 3)))
model.add(Dropout(0.25))
model.add(Conv2D(64, (3, 3), padding="same"))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(64, (3, 3), padding="same"))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Conv2D(128, (3, 3), padding="same"))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(128, (3, 3), padding="same"))
model.add(Activation("relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Dropout(0.25))
model.add(Flatten())
model.add(Dense(1024))
model.add(Activation("relu"))
model.add(BatchNormalization())
model.add(Dropout(0.5))
model.add(Dense(n_classes))
model.add(Activation("softmax"))
```

Model Summary

```
model.summary()
```

```
 dropout (Dropout)           (None, 85, 85, 32)        0

 conv2d_1 (Conv2D)           (None, 85, 85, 64)        18496

 activation_1 (Activation)   (None, 85, 85, 64)        0

 batch_normalization_1 (Batc  (None, 85, 85, 64)       256
 hNormalization)

 conv2d_2 (Conv2D)           (None, 85, 85, 64)        36928

 activation_2 (Activation)   (None, 85, 85, 64)        0
```

```
  conv2d_4 (Conv2D)           (None, 42, 42, 128)       147584

  activation_4 (Activation)   (None, 42, 42, 128)       0

  batch_normalization_4 (Batc  (None, 42, 42, 128)      512
  hNormalization)

  max_pooling2d_2 (MaxPooling  (None, 21, 21, 128)      0
  2D)

  dropout_2 (Dropout)         (None, 21, 21, 128)       0

  flatten (Flatten)           (None, 56448)             0

  dense (Dense)               (None, 1024)              57803776

  activation_5 (Activation)   (None, 1024)              0

  batch_normalization_5 (Batc  (None, 1024)             4096
  hNormalization)

  dropout_3 (Dropout)         (None, 1024)              0

 dense_1 (Dense)             (None, 15)                15375

 activation_6 (Activation)   (None, 15)                0

=================================================================
Total params: 58,102,671
Trainable params: 58,099,791
```

```
opt = Adam(lr=INIT_LR, decay=INIT_LR / EPOCHS)
# distribution
model.compile(loss="binary_crossentropy", optimizer=opt,metrics=["accuracy"])
# train the network
print("[INFO] training network...")
```

```
[INFO] training network...
/usr/local/lib/python3.9/dist-packages/keras/optimizers/legacy/adam.py:117: UserWarning
  super().__init__(name, **kwargs)
```

```
history = model.fit_generator(
    aug.flow(x_train, y_train, batch_size=BS),
    validation_data=(x_test, y_test),
    steps_per_epoch=len(x_train) // BS,
    epochs=EPOCHS, verbose=1
    )
```

```
<ipython-input-27-f5a41846f0f2>:1: UserWarning: `Model.fit_generator` is deprecated and
  history = model.fit_generator(
Epoch 1/25
73/73 [==============================] - 54s 587ms/step - loss: 0.6170 - accuracy: 0.21
```

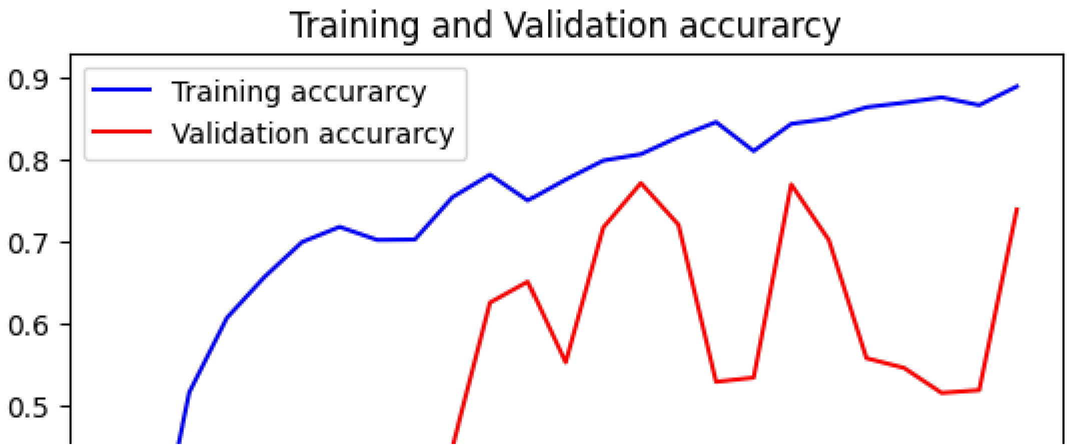
```
Epoch 2/25
73/73 [==============================] - 39s 526ms/step - loss: 0.2858 - accuracy: 0.296
Epoch 3/25
73/73 [==============================] - 40s 550ms/step - loss: 0.1873 - accuracy: 0.516
Epoch 4/25
73/73 [==============================] - 45s 614ms/step - loss: 0.1503 - accuracy: 0.607
Epoch 5/25
73/73 [==============================] - 40s 543ms/step - loss: 0.1305 - accuracy: 0.657
Epoch 6/25
73/73 [==============================] - 39s 530ms/step - loss: 0.1171 - accuracy: 0.699
Epoch 7/25
73/73 [==============================] - 39s 524ms/step - loss: 0.1121 - accuracy: 0.718
Epoch 8/25
73/73 [==============================] - 40s 548ms/step - loss: 0.1140 - accuracy: 0.702
Epoch 9/25
73/73 [==============================] - 40s 547ms/step - loss: 0.1201 - accuracy: 0.702
Epoch 10/25
73/73 [==============================] - 40s 550ms/step - loss: 0.0965 - accuracy: 0.754
Epoch 11/25
73/73 [==============================] - 39s 527ms/step - loss: 0.0872 - accuracy: 0.781
Epoch 12/25
73/73 [==============================] - 38s 515ms/step - loss: 0.0970 - accuracy: 0.756
Epoch 13/25
73/73 [==============================] - 39s 530ms/step - loss: 0.0909 - accuracy: 0.775
Epoch 14/25
73/73 [==============================] - 39s 540ms/step - loss: 0.0815 - accuracy: 0.799
Epoch 15/25
73/73 [==============================] - 39s 536ms/step - loss: 0.0771 - accuracy: 0.806
Epoch 16/25
73/73 [==============================] - 38s 513ms/step - loss: 0.0725 - accuracy: 0.827
Epoch 17/25
73/73 [==============================] - 40s 543ms/step - loss: 0.0661 - accuracy: 0.845
Epoch 18/25
73/73 [==============================] - 39s 533ms/step - loss: 0.0757 - accuracy: 0.816
Epoch 19/25
73/73 [==============================] - 39s 536ms/step - loss: 0.0655 - accuracy: 0.843
Epoch 20/25
73/73 [==============================] - 38s 519ms/step - loss: 0.0637 - accuracy: 0.856
Epoch 21/25
73/73 [==============================] - 39s 534ms/step - loss: 0.0591 - accuracy: 0.863
Epoch 22/25
73/73 [==============================] - 39s 539ms/step - loss: 0.0566 - accuracy: 0.869
Epoch 23/25
73/73 [==============================] - 39s 536ms/step - loss: 0.0536 - accuracy: 0.875
Epoch 24/25
73/73 [==============================] - 40s 546ms/step - loss: 0.0559 - accuracy: 0.866
Epoch 25/25
73/73 [==============================] - 37s 512ms/step - loss: 0.0489 - accuracy: 0.889
```

Plot the train and val curve

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

```
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(acc) + 1)
#Train and validation accuracy
plt.plot(epochs, acc, 'b', label='Training accurarcy')
plt.plot(epochs, val_acc, 'r', label='Validation accurarcy')
plt.title('Training and Validation accurarcy')
plt.legend()

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



Model Accuracy

```
print("[INFO] Calculating model accuracy")
scores = model.evaluate(x_test, y_test)
print(f"Test Accuracy: {scores[1]*100}")
```

```
[INFO] Calculating model accuracy
19/19 [==============================] - 1s 36ms/step - loss: 0.4226 - accuracy: 0.7394
Test Accuracy: 73.94247055053711
```

Save model using Pickle

```
print("[INFO] Saving model...")
#file_name='cnn_model.pkl'
pickle.dump(model,open('cnn_model.pkl', 'wb'))
model.save('C:\\Users\\en0216\\Downloads\\cnn_model.pkl')
print("saved")
```

```
[INFO] Saving model...
WARNING:absl:Found untraced functions such as _jit_compiled_convolution_op, _jit_compile
saved
```

```
image_dir="/content/PlantVillage/Potato___Early_blight/0a8a68ee-f587-4dea-beec-79d02e7d3fa4__
#image_dir="C:\\Users\\SHARATHVEER REDDY K\\Desktop\archive\\PlantVillage\\PlantVillage\\plan

im=convert_image_to_array(image_dir)
#print(im)
np_image_li = np.array(im, dtype=np.float16) / 225.0
npp_image = np.expand_dims(np_image_li, axis=0)
```

```
result=model.predict(npp_image)

print(result)
```

```
1/1 [==============================] - 1s 808ms/step
[[2.45745896e-10 1.19988139e-13 9.99989748e-01 1.00895923e-05
  1.04400236e-07 9.26742594e-09 3.35180234e-12 3.14643245e-09
  6.45471324e-18 2.41527336e-11 6.85825216e-11 3.98020999e-13
  1.96255494e-11 8.41335855e-12 1.17772512e-08]]
```

```
itemindex = np.where(result==np.max(result))
print("probability:"+str(np.max(result))+"\n"+label_binarizer.classes_[itemindex[1][0]])
```

```
probability:0.99998975
Potato___Early_blight
```